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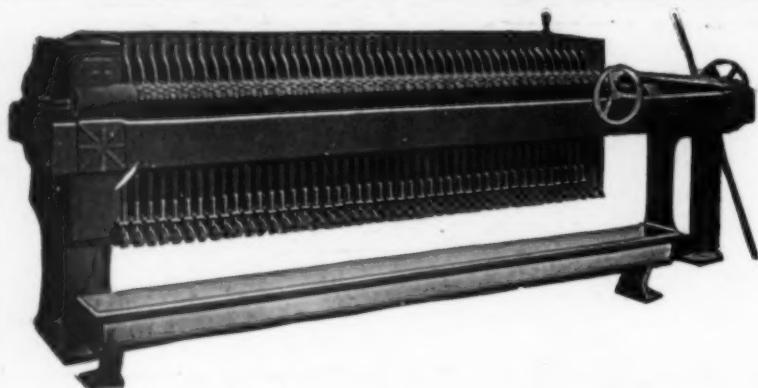
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When Does an Employment Contract Terminate?

THE discussion on this subject, which has appeared from time to time in these pages, has been of much interest and value. There can be no doubt that there exists some dissatisfaction over contracts offered technical men and the suspicion seems not ill founded that there may be some injustice in them. It is, therefore, not undesirable perhaps to summarize the situation and endeavor to arrive at some fair and constructive conclusion.

First, from the standpoint of the technical man there appears to be agreement that there is a vagueness about the average contract offered technical men which opens the door to misunderstandings. These misunderstandings apparently are due for the most part to the technical man's ignorance of his own right. He may be considered partly to blame for this, but the system under which he is trained is certainly more to blame than the individual himself. The most important right to him is his right to be recompensed for discoveries made while working on a salary, through his ownership of shop rights in discoveries which he has made. Under present practice he is very apt to sign away these rights in a contract which is perfectly valid. If, now, the knowledge of these inherent rights were a matter of general comprehension, it would be unlikely that an employing corporation would embody in the contract such usurious exactions as a price of employment. That there exists a suspicion on the part of the employee that he is the victim of an unavoidable and unfair condition is a well-established fact. How much better it would be for all concerned if the technical man were promised a fair return for discoveries which he might make while in the employ of the company.

The second cause for considerable dissatisfaction among technical men is the curtailment of their field of usefulness outside of the employer's factory walls. It has been decided legally that such restriction is unenforceable and the knowledge of such decision is fairly widespread among technical men. The insertion of such clauses in an employment contract is usually intended to intimidate the technical man and in so far as they have a deterrent action upon dishonest employees, they have fulfilled their function.

There seems also to be a complete unanimity as to the employer's duty and privilege to protect his property rights. These property rights would seem to include all the knowledge which he possessed up to the time of the employee's engagement and all other knowledge gained during the employee's stay which was not developed by that particular employee himself. The great difficulty seems to be as to how much property right the employer has over uninvited things that the employee may contribute in the future while working under

a salary. The consensus seems to be that no man should be asked to sign away an interest in an invention not yet made and that perfect justice would give the employee some personal share in the work of its success.

The whole situation actually rests with the employer. With technical men as a class, it can be said with considerable confidence that in so far as they are trusted and in so far as their own aims and aspirations are made coincident with those of the employer, just so far will the employer enlist their loyalty. No employer has the logical or actual right to demand loyalty from an employee when he demands service which not only does not develop, but actually cramps and hinders the employee's career. We doubt if legislation would be of assistance, for unless the relationship is above any legal plane it ceases to be desirable either to the employer or the employee. We do believe, however, that teachers of chemistry and chemical engineering can make a distinct contribution toward remedying the situation by arranging with competent counsel for one or two lectures a year on the elements of contractual relations.

Discredited Among His Colleagues

SENATOR KING undertook to break down the dye industry of this country by one of the most vitriolic attacks which has ever been made in any Congress upon any young and growing branch of business. He charged monopoly. He charged everything else which might discredit the industry in the eyes of the public. Backed by statistics which contained just sufficient truth to be believable by many, he urged and finally obtained authorization for a Senate investigation. Thanks to Senator FREYLINGHUYSEN, this investigation was made to cover not only the producer but also the importer of dyes. And now the investigation has virtually reached its end.

As a result of the very comprehensive proceedings under the able chairmanship of Senator SHORTRIDGE, it has been conclusively demonstrated that Senator KING's charge of monopoly is simply bunk. He and the various witnesses from all quarters have conclusively proved that there are in the industry several very large companies. That is all that has even been seriously charged by any one appearing before the committee. Even the most vigorous opponents of an embargo for the domestic dye producers have been forced to deny that there is anything approaching monopoly.

But incidentally the investigation has demonstrated another thing. It has most convincingly set before the members of the Senate the real situation with reference to the organic chemical industries of the United States. The investigation can, in fact, be credited with having convinced the Finance Committee of the Senate that an extension of the embargo on dye importation was desirable. It seems to be unquestioned that it was the

proceedings which started as an attack upon the industry that ultimately proved a tremendous blessing in this particular.

As things now stand, we cannot know for some time what the Shortridge committee has concluded or will recommend to the Senate. The chairman of the committee and the other members of the Senate interested have, however, said enough so that it may be safely forecast that the conclusions and recommendations will be in general favorable and beneficial to the American dye producer.

The industry has come through with a clean, fine record. It is going to be given a slightly extended period of protection against unrestricted import. For at least one year, and more likely two years, after the passage of the pending tariff bill (assuming that that bill ever does pass), a license for imports will be required. What may happen after that no one now can forecast. But there still remains a considerable period in which to set in order the defenses of this industry to meet any mass attack through importation.

The most effective defense against that attack will be the result of research applied as improved technology. If there ever has been a time in any chemical industry when research was needed, it is now in the dye industry. Through research and its application to processes and products, the industry may hope permanently to meet any foreign competitor. American inventive genius, American methods of economical mass production, and clean-cut, vigorous American business methods can well expect this success if they are builded upon sound science and the best possible technology. However, without that foundation none, nor even all of them, can succeed.

Steel Makers Dine With the President

SOME of the commonest things today were quite novel when introduced. The nothing-new-under-the-sun dictum must be adopted with reservations. The first umbrella was a startling innovation and there was even a time when clothes were not worn.

It is a new thing for the President of the United States to invite representative members of the steel industry to dine with him, yet it is not difficult to conceive of such contacts becoming common. Why should not the head of the nation talk frankly with groups of men who have much to do with the course of everyday affairs in the country?

The news dispatches from Washington told of President HARDING having at dinner with him on the 18th twoscore or more of representative steel manufacturers, to discuss informally the subject of the 12-hour day in the iron and steel industry. The dispatches did not bring out the naturalness of the thing, possibly because it is unnatural for newspaper men to seek to minimize the novelty of what they report. But when the head of a large corporation finds in his reports something that he thinks can be improved upon, he is likely to call a conference of those involved. Now the fact is that the Department of Labor has in press at the present time a new report on "Hours of Labor in the Iron and Steel Industry." The report, according to the statement released for the press a week ago, "shows that a considerable change was made in the hours of labor of employees between 1910 and October, 1920, the date of the last figures in the report." It seems like rather a be-

lated report, of course, but probably it was only recently placed before the President. So it is not strange that Mr. HARDING, seeing the report, might conceive the idea of inviting some of the men who have to do with this matter to dine with him and go over the ground. In ten years progress had been made in reducing the proportion of 12-hour employment, why not see if the progress could not be stimulated?

Business men of the United States are anxious to be in real contact with the government. The saying "Less government in business, more business in government" is not contradictory. The difference is between natural contact and the uncomfortable contact that comes from impact. The steel industry itself furnishes a good illustration. The U. S. Steel Corporation was formed in the spring of 1901. In 1908, testifying before the Stanley committee, Judge GARY, chairman of the Steel Corporation from the outset, said plainly and earnestly that he would welcome an arrangement whereby the Steel Corporation would lay all its information before the government and the government would then tell it what it should do and what it should not do. Three years afterward, more than ten years after the corporation had been formed, the government brought suit against it for dissolution. By a Supreme Court decision of four to three the Steel Corporation survived the impact, but it was not the kind of contact that has been found good in the conduct of business.

The Constitution of the United States, by the way, requires the President to inform Congress from time to time as to the state of the Union. Some Presidents have used many thousands of words in telling about government departments rather than the state of the country. In inviting groups of men to dine with him the President is seeking just such information as he ought to have.

Along This Road Lies Profit

HENRY FORD states in his autobiography—now being published in *McClure's Magazine*—that the way to profit in automotive manufacture is first to settle definitely on the design of the motorcar and then devote all possible effort to improving the equipment and methods by which it is produced, rather than to endeavor to change the design and bring out a "new" model from time to time. The success which he has attained by following these methods has been so conspicuous that it would not seem possible to arouse much opposition to the statement. Nevertheless, many do not seem to accept this as true and prefer to look to luck or some other intangible factor as the touchstone of FORD's success.

If we change the above to fit the chemical industries, it would read something like this: The way to profit from chemical manufacture is to settle definitely on the process to be used and then to devote all possible effort to improving the machinery and methods by which this process is accomplished. This is, unfortunately, even less an accepted maxim of chemical manufacture than it is of automotive industry. The actual method more often followed seems to be, rather, to go on with a manufacturing process in exactly its original form until someone invents a new process or a better product as a substitute and, by the advantage thus gained, eventually forces everyone concerned to adopt the new way.

Our suggestion is in no way to be taken as con-

demnation of scientific research, which is essential to progress in industry. Rather is it a plea that some of the research be directed to developing better equipment for already established processes and finding better ways of operating and managing them. To do this may curtail to some extent the amount available to be spent in research along new lines, but from both the social and business viewpoints we feel that it is perhaps better that the cause of science should suffer temporarily until money is available for full efforts along both lines. This is because the road traveled toward perfection in equipment and method also leads us to far better working conditions for the employee and, for the employer, to the goal of all endeavor—increased profits.

Sulphur and Manganese In Rivet Steel

"HIGH SULPHUR" has long been one of the accepted excuses for baffling defects; sulphur has universally been condemned as an ingredient in steel.

And yet after a careful search in literature we were unable to find any metallurgist placing a definite limit on sulphur for any particular class of steel and giving anything like a clear idea of what would happen if the danger line was overstepped. Steels made before the advent of chemical specifications wore out after long and honorable service before they were discovered to be "dangerously high" in sulphur. In more recent and scientific years chemical specifications for sulphur in steel have varied geographically to a certain extent. The Swedes insist on very low sulphur; the English are much more tolerant; the Americans occupy a middle ground. One almost suspected that a piece of steel if it were honestly and skillfully made would not be spoiled for ordinary uses in rails, shapes or plates by any reasonable amount of sulphur. Perhaps sulphur has been taking the blame all these years because it can be determined chemically, while dissolved gases cannot. Perhaps, too, the excess manganese demanded to "neutralize the sulphur" also did unnoticed yeoman service in neutralizing the oxygen.

But now we have some real information on the subject! An important report on the "Effect of Sulphur on Rivet Steel" has been issued, containing the first data issued since the Joint Committee commenced its work, two years ago. It contains, in graphical form, the results of an exhaustive series of thousands of tests on several selected steels, held as constant in chemical composition as possible except as to sulphur. Apparently here are the data necessary for judging and condemning the culprit—but for reasons of its own, the committee has abstained from any comment on the significance of the tests, leaving each interested engineer to draw his own conclusions. This has been done by one of the editors of CHEM. & MET. for his own edification and perhaps for that of others, as set forth on page 1019 of this issue.

One is tempted to speculate upon the reasons why the committee, which undoubtedly is best qualified to interpret the results, did not state in words the plain indication of the tests. Primarily, the investigation was undertaken to determine whether the war-time specifications permitting high sulphur could be safely retained. Well, can they?

Perhaps the committee declined to say yes or no to such a direct question because it has found that this monumental investigation has tested more than the

effect of sulphur in steel. Primarily it has tested our methods of testing—not only their competence but their significance. It has raised such questions as this: What standardized test will give the same indications that can be had from pulling a joint apart, breaking tightly stretched rivets by combined crushing, bending and shear? This question of *competence* of test should seemingly have been decided long ago. Else why spend so much time testing slabs in torsion, for instance? From the published curves, shearing tests on a plain bar are found to parallel strengths of riveted joints admirably, the good old ultimate strength in tension is a close second.

Again, what impact test shall we use? Impact shear on rivet bars in the annealed state are approximately the same as when received from the mill; while Charpy values for annealed bars are cut down 80 per cent. Shall we accept the impact shear, or the Charpy results? Furthermore, it appears to be immaterial whether an unnotched specimen is broken with or across the direction of rolling—the work expended is substantially the same. It may be debatable whether the result of the impact tests on unnotched specimens denotes a uniform material or an insensitive testing method. It might even be that the impact shear is sensitive and accurate, and the material is uniform. Must we then conclude that both the Izod and Charpy are capricious?

Assuming, however, that all these tests are competent and significant, an inspection will show that high sulphur has surprisingly little effect. Twenty of the graphs, if approximated by a median line sketched freely, actually show well-defined maxima or minima at 0.04 to 0.05 per cent sulphur. This might support the contention of certain manufacturers that it is more damaging to "force" open-hearth heat for extremely low sulphur than to leave it in, were it not for the fact that the manganese curve shows a definite minimum in the same region. In fact one or two of the most jagged curves presented by the committee are less baffling if plotted against manganese! While it would be unfair to suggest that the committee has tested the effect of manganese rather than sulphur, these facts, and the rather wide range of manganese contents, make it certain that the results have actually tested the effect of *sulphur plus manganese* on rivet steel.

Some interesting sidelights appear. An unexpected heat containing 0.18 per cent sulphur suggests that the whole art of open-hearth steel melting has been tested. Furthermore, the comparatively innocuous effect of such dangerously high sulphur has tested one of our cherished metallurgical prejudices. Finally, the heat-treatment of low-carbon steel is before the court, for certainly a correct anneal would not be expected to damage the impact properties so greatly.

Perhaps the Joint Committee may be pardoned for not opening this Pandora's box, but it seems that one conclusion will unavoidably be reached from a study of the published tests, and that is this:

In well-made basic open-hearth steel containing less than 0.02 per cent phosphorus, approximately 0.11 per cent carbon and 0.43 per cent manganese, the maximum sulphur now allowed in rivets for structural steel (0.045 per cent) is at least 0.01 per cent below the quantity where sulphur will damage the strength, at least as far as its performance can be predicted by known tests.

Readers' Views and Comments

Radium Production in America*

To the Editor of Chemical & Metallurgical Engineering

SIR:—In two recent papers of this title by H. D. d'Aguiar,¹ the recovery, refining and measurement of radium from carnotite ore were outlined. While Mr. d'Aguiar does not mention the company employing the practice described, the writer is informed that it was that of the former Radium Luminous Materials Corporation, of Orange, N. J.

It is very gratifying that one of the leading radium companies is willing to give its flow sheet and describe its operations. The radium industry in this country has, in some instances, suffered greatly in the past from the lack of proper technical advice and control. This has been particularly true of companies just beginning to operate. In fact, many operations both early and recent have failed from no other cause than this. There is far less excuse today for such a condition prevailing than 10 years ago. The number of technical men familiar with radium measurements and competent to direct plant operations has increased many-fold in that period. The writer, therefore, welcomes information of the character that Mr. d'Aguiar has presented and believes it will be of benefit to the radium industry. Additional value would have been given to Mr. d'Aguiar's paper had he presented more data in regard to recoveries and costs. Any process, chemical or otherwise, must stand or fall on the efficiency and economy of its operation. The writer will take the liberty of making a few comments on some of the points raised by Mr. d'Aguiar, and also of pointing out features of the process described where additional information would be very welcome.

Mr. d'Aguiar makes the statement that the radium-uranium ratio in carnotite may be altered by contact with water, even by such contact as would be brought about by not keeping the ore entirely dry during storage. While it is not intended to challenge this statement flatly, the writer desires to point out that it is not in accordance with the generally accepted results of dry and wet concentration methods as applied to carnotite. Some experiments on both the wet and dry concentration methods, by the Bureau of Mines a number of years ago, indicated that no change is produced in the radium-uranium ratio. Since that time wet mechanical concentration has been much more extensively employed and additional information on this point by the operating companies would be very valuable.

Mr. d'Aguiar describes the application of the alpha ray method in checking the analytical results for U_3O_8 . The writer has recently commented at length upon the limitations of this method,² and has nothing further to add at present.

The most striking feature in the extraction process described by Mr. d'Aguiar is the use of hydrochloric acid to dissolve the soluble material in the ore, fol-

lowed immediately, without filtration, by the use of sulphuric acid to precipitate radium and barium as sulphates. From the standpoint of economy this procedure could be justified only if it can be demonstrated that sulphuric acid alone will not give equally good extraction. By the addition of sulphuric acid without previous filtration the radium and barium are thrown out of solution with the tailing and must be recovered by a sliming process, which entails the difficulties of carbonation and the recovery of the radium from the slimes. When hydrochloric acid is used as extractant, it is usually with the purpose of separating the solution from the tailings immediately by filtration and obtaining in a single step a high-grade radium-barium sulphate by precipitation. If this procedure is to be sacrificed (and in some cases it is not applicable), one would naturally expect to use the cheaper acid, sulphuric, for the whole digestion of the core, unless it can be conclusively demonstrated that hydrochloric followed by sulphuric gives a better result.

Mr. d'Aguiar's statement that no radium is found in carbonate liquors can scarcely be entirely correct. Barium carbonate must be present up to its solubility in the liquor in question and radium would be contained corresponding to the radium-barium ratio prevailing. For all practical purposes, however, the amount of radium is too low to represent any material loss. Mr. d'Aguiar does not state at what point of the process, nor how, the lead was removed.

The practice of holding radium tubes, even with forceps, while tubing the salt must be regarded as a very hazardous one. In the work of the Bureau of Mines a very simple arrangement was devised which proved entirely satisfactory. A one-hole rubber stopper was forced into a heavy glass inkwell with a flat base, which prevents the possibility of tipping over. The bottom of the tube to be filled is then inserted for a short distance into the hole in the stopper, which holds it firmly in a vertical position, and at the same time permits all the necessary play for tapping during the tubing operation.

The practice of discarding uranium is very regrettable, but, as Mr. d'Aguiar states, the market conditions have not justified its recovery. Some companies have run the byproduct into sumps from which it could be recovered if a demand ever arises. It is not at all improbable that a use will some time be discovered for this rare metal which will make it extremely valuable.

Regarding the practice described for the measurement by radium of the emanation method, a chamber of 10 liters capacity seems unnecessarily large. Physicists in the past have complained that chemical methods are crude in being able to deal quantitatively with matter only in relatively large quantities. This criticism would appear just if we admit that it is necessary to employ a capacity of 10 liters in measuring a volume of emanation which itself is of the order 5×10^{-3} cu.mm.

The use of such a large volume entails certain disadvantages. The volume of air to be dried is so great that one cannot use conveniently a small system containing concentrated sulphuric acid, but is forced to

*Published with the permission of the Director of the Bureau of Mines.

¹CHEM. & MET. ENG., vol. 25, pp. 825-28, 877-80 (Nov. 2 and 9, 1921).

²J. Ind. Eng. Chem., vol. 12, p. 469 (1920).

resort to the use of solid calcium chloride. On account of the danger of adsorbing radium emanation, it has not been regarded as good practice to pass it over porous solids. The only reason which requires the use of such large volumes is in itself not sound in principle, since the emanation to be measured is removed from the solution by aspiration at ordinary temperature instead of by boiling. It has long been realized that the complete aspiration of radium emanation from water at ordinary temperature is a slow and uncertain process. This point has recently been reiterated by M. Walter Mund' in another connection. By far the superior practice consists in boiling the solution; the volume of steam produced sweeps it out completely in a short time and is again condensed so that the volume of air actually introduced is much smaller and an electro-scope of $\frac{1}{2}$ liter capacity is sufficient for all purposes.

In connection with the standardization of emanation chambers, the preparation of a standard solution from 1 mg. of radium measured by the gamma ray method would scarcely afford the desired degree of accuracy. It is much better to make up a solution employing a large quantity of salt, which can be more accurately measured, dilute this solution to the desired standard and return the remainder immediately into the form of salt. It is also to be borne in mind that fluctuations in temperature or pressure will produce corresponding errors in the result obtained with a calibrated chamber, unless correction is made. When both of these errors happen to be in the same direction, they can easily amount to 2 or 3 per cent. The ideal system is to have an air bath which can be regulated to correspond to the prevailing barometric pressure on each day so that all emanation chambers can be filled with an air concentration corresponding to that at which they were standardized.

Mr. d'Aguiar's method described for the treatment of sulphates in order to bring the radium into solution for measurement involves a rather difficult operation in duplicate. If the silica content of the sulphates is too high to render the sodium carbonate fusion method applicable,⁴ then the bisulphate fusion method of Barker⁵ may be used conveniently, or the SiO_2 may be removed by HF before the carbonate fusion.

It is not clear whether Mr. d'Aguiar's statement in a footnote, to the effect that the nitric acid extraction method is needlessly expensive and that only 1 g. of radium has been produced by it, is general, or whether it refers only to the experience of his own company. If he means it as a general statement, it may be of interest to recall that the Bureau of Mines produced between $8\frac{1}{2}$ and 9 g. of radium element by the nitric acid method, which was not only found to be entirely satisfactory but which was above criticism from the cost standpoint, as the following statements will show: The costs published in Bulletin 104 by the Bureau of Mines were \$37,500 per gram of radium. These costs were estimated from the production of 1 g. during the course of operation. It has been supposed by some radium producers that the estimate was too low, but, as a matter of fact, it has proved to have been fairly close. When the entire operations of the National Radium Institute were brought to a close, it was found that the net expenditures of the corporation, after

deducting for the sale of the plant, byproducts, etc., was a little over \$300,000. (No allowance has been made for 30 tons of high-grade black oxide of uranium produced as a byproduct, which has not yet found a market.) Add to this an overhead of \$50,000 on the part of the Bureau of Mines, which is a very liberal estimate, divide by 8.9 g., the amount produced, and a cost is shown of \$39,325 per gram. It is not meant to imply that this would be a fair figure today under the present cost of chemicals, labor, etc., but it is meant to state that for such ores as are amenable to nitric acid extraction it can compete in cost, when the nitrates are recovered from the tail liquor and the nitric acid is regenerated, with any other method hitherto proposed. In addition it possesses the distinct advantage of furnishing in a single step a high-grade radium-barium sulphate which can be directly converted into soluble form and introduced into the crystallizing system, without the troublesome steps necessary when a less pure sulphate is produced by a sliming method. In the writer's opinion, radium producers who have carnotite ore reasonably free from sulphate, which is, therefore, amenable to nitric acid extraction, make a mistake in overlooking the possibilities of the nitric acid method.

In closing, the writer would like to say that the radium industry is much indebted to Mr. d'Aguiar for the interesting information contained in his two papers and that it is only to be hoped that he will supplement it with statements regarding the relative amounts of radium passing through the different stages of the process described, and give other details and data which would be of the greatest value to those engaged in the radium industry.

S. C. LIND.

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Explosion Hazard in the Darling Process of Electrolyzing Sodium Nitrate

To the Editor of Chemical & Metallurgical Engineering

SIR—In reading the first installment of Mr. Batsford's valuable article on "Metallic Sodium," which appeared in your journal for May 10, I find that, on page 891, following his description of the "Darling Process Using Sodium Nitrate," he says: "Unfortunately the explosion hazard was too great a drawback, and the process was abandoned about the year 1905." As expert special agent in charge of the chemical industries at the census of 1900 I investigated the Darling process, then being operated at the works of Harrison Bros. & Co., Philadelphia, and on pages 50-51 of Bulletin 210 of the Twelfth Census of the United States I have given a description of the process. During my investigation I learned that the quantity of metallic sodium accumulated in storage at the works had become so great the city authorities, fearing accidents, compelled the cessation of operations. It was my understanding that the menace was in the product and not in the process and that this menace will hold for any and all processes for the isolation of sodium. This is a factor of great weight in determining the location of a plant for this industry and in designing the methods for collecting, handling and storing the sodium.

CHARLES E. MUNROE.

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National Research Council,
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¹J. phys. radium, vol. 2, pp. 381-2 (1921).

⁴J. Ind. Eng. Chem., vol. 7, p. 1024 (1915).

⁵J. Ind. Eng. Chem., vol. 12, p. 525 (July, 1918).

American Iron and Steel Institute

Twenty-first General Meeting at Hotel Commodore, New York City—Judge Gary's Opening Address—Technical Program With Papers on Australian Iron and Steel Industry, Electrification of Steel Mills, Adirondack Iron Ores, Fuel in Open-Hearth Practice, and Gas and Air Valves for Open-Hearth Furnaces

THE twenty-first general meeting and annual spring session of the American Iron and Steel Institute was held on Friday, May 26, 1922, at the Hotel Commodore, New York City. The program consisted of a morning session with an address by President Elbert H. Gary and technical papers, luncheon, an afternoon session of technical papers and discussion, and a banquet in the evening, followed by impromptu speaking in response to the call of President Gary.

There was a large attendance of the members and their guests at both the morning and afternoon sessions and at the banquet. A general tone of good-spirits and optimism was evident and confidence in the return of good conditions to the industry was evidenced on all sides. Field Marshal the Right Honorable Earl French of Ypres was the guest of honor at the banquet and spoke briefly in appreciation of the American iron and steel industry.

Morning Session

The morning session was opened with the customary address by the president of the Institute. Judge Gary opened his remarks with an appreciation of the services to humanity in general and the iron and steel industry in particular rendered by the late Dr. Henry M. Howe, whose memory was honored by a silent standing tribute on the part of the whole assemblage.

President Gary then spoke of the dinner given on May 18 by President Harding, who at that time had forty members of the A.I.S.I. as his guests at the White House. The newspapers were in the main correct in their reports of this meeting, at which President Harding came out frankly and asked the iron and steel industry to do all in its power toward adopting a uniform eight-hour day. The matter was discussed fully among those present and a motion was passed that Judge Gary appoint from the A.I.S.I. a committee whose duty it should be to make a thorough and unbiased investigation as a basis for a report and recommendations upon which the A.I.S.I. might take such action as then seemed appropriate. It was urged on all present that they extend their prompt co-operation to this committee, furnishing all the data pro and con which their industrial connections made available, and always keeping in mind that President Harding's wishes should be fulfilled if such proved to be at all possible.

JUDGE GARY'S ADDRESS

President Gary then delivered his address, the subject of which was "Current Legislation." After pointing out the necessity for full and impartial administration of all the laws on the statute books and urging the patriotic duty of all iron and steel men to see that this course was followed, he touched on the legislation now before Congress on the tariff, government regu-

lation and soldiers' bonus, giving his opinion of the course that should be followed that all in the country might derive the most benefit. The sales tax was advocated, whether the bonus legislation passed or not, as being fairer to all concerned and better for the business life of the country than the methods of revenue raising now in vogue. The address closed with a word of optimism and encouragement as to the present and future of the iron and steel industry.

ADDRESS BY SIR WILLIAM B. PEAT

Following Judge Gary's address, Sir William B. Peat was introduced to the meeting. Sir William has long been influential in iron and steel circles and, an early member of the Iron and Steel Institute of London, was instrumental in the founding of the A.I.S.I. He spoke briefly on the position of the iron and steel industry of the United States in world trade and expressed the opinion that the United States should seek the financing and control of the industries of other countries as England had done a hundred years ago, stating that only in this way could world trade and industry quickly regain their former level.

IRON AND STEEL IN AUSTRALIA

A paper on "The Development of the Iron and Steel Industry in Australia" was read by David Baker, general manager of the Broken Hill Proprietary Co., Newcastle, New South Wales. The important iron ore resources of Australia are stated to be as follows: Western Australia, 97,500,000 tons; South Australia, 130,000,000 tons; Victoria, 750,000 tons; Tasmania, 41,900,000 tons; Queensland, 500,000 tons, and New South Wales, 53,017,000 tons. There are numerous other rich deposits; but due to their present inaccessibility they were not listed.

The manufacture of iron and steel has made various sporadic starts in the different Australian states; but only in New South Wales, where the industry was commenced in 1852 at the Fitzroy Iron Works, has the development been steady. Following the formation of this company, the Lithgow Iron Works was founded in 1874, becoming the present Hoskins Iron & Steel Co., Ltd., in 1908. The Broken Hill Proprietary Co., founded in the early days of Australian gold mining for the production of gold, silver and lead, originally purchased the iron mines at Iron Monarch and Iron Knob for use in supplying flux for its lead smelters at the Port Pirie Works. In 1911 this company made an investigation of the possibilities of steel manufacture and then commenced this manufacture at Newcastle in 1915. The production of these two last companies is as follows: Hoskins Iron & Steel Co., Ltd., 150,000 tons of pig per annum; Broken Hill Proprietary Co., 600,000 tons of steel per year. There are numerous other companies of less importance for the production of pipe, wire, black and galvanized sheets and other materials.

Afternoon Session

RELATION OF THE DOCTOR TO THE STEEL PLANT

The first paper of the afternoon session was an interesting exposition of the "Relation of the Doctor to the Steel Plant," by Dr. L. A. Shoudy, chief surgeon of the Bethlehem Steel Corporation. Dr. Shoudy pointed out the importance of employing only the highest class of physicians and installing the best of hospital and medical equipment. The important function of the doctor is, by anticipating and removing the causes of ill health in environment and in the human machine, to keep production and efficiency at a high level. In conclusion, he stated that in times of trouble the worker looks on the doctor as a friend who understands and hence the right type of doctor can form a valuable contact between the steel company and the workers.

ELECTRIFICATION OF STEEL PLANTS

Wilfred Sykes, of the Steel & Tube Co. of America, read a paper on "The General Effect of Electrification on the Operation of Steel Mills," which stated that it is important that those concerned in steel mill operation should understand the essentials of electrification, as the extension of the steel industry in the future will consist as much of modernization of the old mills as of building new mills, and in this case the main drives will all become electric, as the auxiliary drives now are. The paper then proceeds to give numerous and illuminating examples of operation of electric drives for main rolls and auxiliary mills. An interesting chart shows the progress in use of electric drives on main rolls from 1906 to 1921, the total horsepower in use having increased in that time from about 50,000 hp. to approximately 925,000 hp.

Mr. Sykes gives some interesting figures on the delays resulting from the electrical driving of the reversing drive of a 30-in. universal plate mill at the South Chicago works of the Illinois Steel Co., which was installed in 1907 and was the first to operate. During a total working time of 100,000 hours since that time the mill has had a total delay of 525 hours due to electrical troubles. In 1920, after 13 years' operation, there were no delays, although this mill rolled in this year 20 per cent more than in any of the first 10 years of its life.

USE OF FUEL IN OPEN-HEARTH FURNACES

Herbert F. Miller, Jr., assistant superintendent of the Lackawanna Steel Co., in a paper on "Methods of Using Fuels in Open-Hearth Furnaces," stated that the field in which ideas for developing power of open-hearth fuels are hidden has barely been scratched. From experiments covering the past ten years on the use of various fuels in open-hearth furnaces he found methods of producing much better flames than are in general use in open-hearth practice. In a producer gas type furnace with a single brick gas port, oil was used for fuel and was introduced through a water-cooled tuyere which projected across the uptake and terminated just short of the nose of the port. This tuyere was pulled back until it terminated over the uptake. The result was such an intensely hot flame that the arch of the port melted and the roof of the furnace burned. However, this flame was used a sufficient time to show that the time of the heats could be reduced from 6½ hours to 4 hours. The reason of the high heat was that the great speed of the oil fuel across the uptake and

through the gas port caused it to act as an aspirator for the preheated air in the uptake. Hence the vaporized oil and the air united under pressure and at great speed in a mixing chamber of small cross-section and the condition approached the ideal for perfect combustion. Similar experiments on other fuels and in specially built ports proved that these effects could always be reached. The trouble is that the furnaces now in use cannot stand the heats obtained in this manner. Mr. Miller suggested the construction of open-hearth furnaces along the lines followed to produce the modern high powered blast furnace and that eventually it will be possible to tap heats charged with scrap and cold pig iron in three to four hours after starting to charge, when conditions of high pressure air and gas are developed.

IRON ORES OF THE ADIRONDACKS

In 1916 F. S. Witherbee, of Witherbee, Sherman & Co., read a paper on this subject. F. L. Nason, the geologist of this company, now presents a paper which supplements and gives further details on this subject and is entitled "The Importance of the Iron Ores of the Adirondack Region." The paper states that there are about 250,000,000 tons of titaniferous ores, and that the total tonnage of both titaniferous and magnetite ores, known and prospective, is 1,736,000,000 tons. Of this amount there is 186,000,000 tons of ore assured. At the present rate of production, about 1,500,000 yearly, the yield to be expected from the rest of the field will be known long before this amount is exhausted.

The paper states also that this region is capable of producing not less than 600,000,000 tons of 61 to 65 per cent concentrates of bessemer grade in phosphorus, of which probably one-half would be "special low phosphorus." Unit for unit, these concentrates can be marketed on even terms, at some point not far east of Buffalo, with the best of the Lake ores.

GAS AND AIR VALVES FOR OPEN-HEARTH FURNACES

William C. Bulmer, of the Carnegie Steel Co., in a paper on "Gas and Air Valves for Open-Hearth Furnaces," traced the development of these valves from the earliest Siemens furnace down to the types in use today. He stated that the chief requisites of a proper valve are an effective seal and an unrestricted passage. The paper divides valves into three groups—namely, one-way, two-way and four-way, depending upon the number of directions of gas or air passage through them. The one-way group alone offers means of regulating the flow to and from each checker chamber without additional equipment. This valve also permits any desired proportion of the waste gases to be put through either chamber. By regulation of the incoming gases also during periods of shutdown, such as Sundays, a much better temperature can be maintained.

Valve types are classified in this paper as slide, butterfly, mushroom and movable hood—also as dry, refractory-lined, water-cooled and water-sealed. The various advantages and disadvantages of these different qualities are given. From these data the paper concludes that the one-way, water-cooled slide valve with inclined seat comes nearest to perfection in so far as the requisites of effective seal and unrestricted passage can be obtained with good mechanical construction, accessibility for repair, low maintenance cost and various other factors.

Henry Marion Howe

HENRY MARION HOWE died at his home at Bedford Hills, N. Y., on Sunday, May 14, 1922, from a malady which had confined him to his house for more than a year. Living to the ripe age of 74 years, his achievements may be fittingly expressed in the words with which Albert Sauveur conferred the John Fritz Medal:

"Lover of justice and humanity,

"Public servant and public benefactor,

"Master of the English language,

"Loyal and devoted friend,

"Untiring and unselfish worker in an important field of science,

"Stimulating teacher, inspiring investigator and generous collaborator,

"Voyager in realms but dimly perceived by fellow-workers,

"Lone explorer of fields destined to yield rich harvests to future generations,

"Man of genius, honored and loved the world over."

Henry Marion Howe was born March 2, 1848, at Boston, Mass. His father was Dr. Samuel G. Howe, famous for his service to Greece in her war for independence (from 1824 to 1830) and later for his labors in the instruction of the blind. His mother was Julia Ward Howe, author of *The Battle Hymn of the Republic*, and leader in many reforms.

He was graduated in 1865 from the famous Boston Latin School, and four years later received his degree as Bachelor of Arts from Harvard College. Thus equipped, he entered the Massachusetts Institute of Technology, which gave him in 1871 the degree of "Graduate in the Department of Geology and Mining Engineering"—a cumbrous title for which the institution substituted, a few years later, that of "Bachelor of Science." And Harvard made him Master of Arts in 1872, and Doctor of Laws in 1905.

With the exception of approximately five years devoted to the metallurgy of copper, during which he inaugurated copper smelting in Chile, designed and built the works of the Orford Nickel & Copper Co. at Capelton and Eustis, in the Province of Quebec, Canada, and at Bergen Point, N. J., and managed the Pima Copper Mining & Smelting Co. in Arizona, Dr. Howe's whole professional life had been devoted chiefly to the development of the iron and steel industry, as superintendent of steel works (Joliet, 1872, and Pittsburgh, 1873-4), consulting metallurgist, teacher of metallurgy, in-

vestigator, interpreter, writer and presiding officer. While acting as consulting metallurgist he was lecturer on metallurgy at the Massachusetts Institute of Technology from 1883-1897, professor of metallurgy at Columbia University, 1897-1913, and professor emeritus, 1913-1922.

For the last fifteen years he declined as far as practicable all professional business in order to devote himself exclusively to what had clearly become the great scientific mission of his life, a task unfortunately not completed. Dr. Rossiter W. Raymond, in an address in 1917, thus describes it:

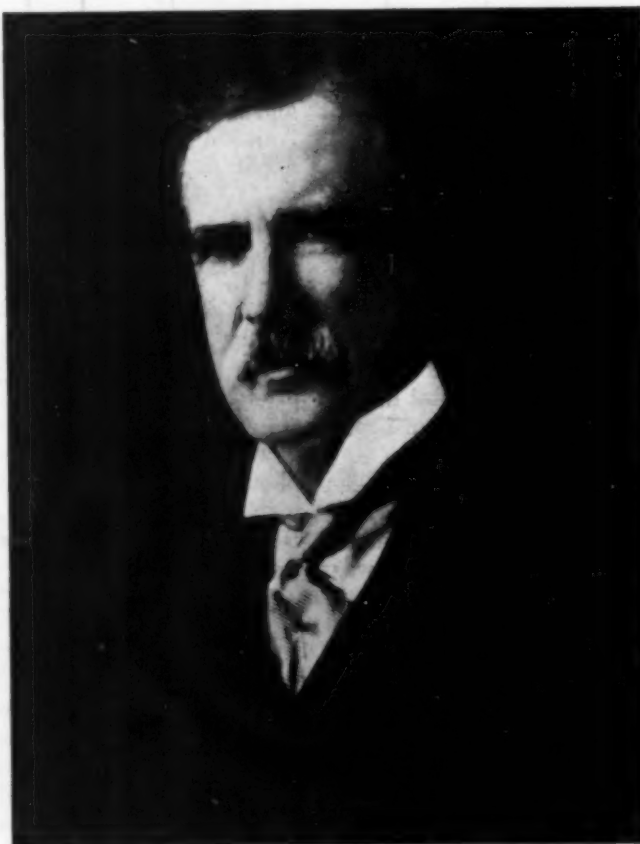
"It gives me pleasure to fancy, whether or not the fancy be also fact, that I remember the beginning of that mission, forty-odd years ago. In 1871, the first year of the existence of the American Institute of Mining Engineers, Mr. Howe, then just graduated from the

Massachusetts Institute of Technology, became a member of the new organization. His two earliest contributions to its *Transactions*, 'Blast-Furnace Economy,' in volume 3, and 'Thoughts on the Thermic Curves of Blast Furnaces,' in volume 5, indicated already that he was making a scientific study of practice. But between the dates of these papers a famous controversy was inaugurated in the forum of the Institute by the brilliant paper of Alexander L. Holley, *primus inter pares*, entitled 'What Is Steel?' In his controversy eminent metallurgists like Wedding, chemists like Prime, and expert captains of industry like Metcalf vigorously took part; but of all the knights of the tourney, none rode a straighter course or laid in rest a sharper lance than Howe, whose paper on 'The Nomenclature of Iron' ardently advocated a scientific as distinguished from a commercial no-

menclature. To tell the truth, the battle had a commercial origin. The real question at issue was not, What is steel? but, What may fairly be called steel at the custom house?

"Well, there was even an international committee on the subject, and the committee made a report. The tariff difficulty was adjusted somehow; the antagonists shook hands; the thunder of the captains of industry and the shoutings died away. But one man continued the inquiry fiercely in his own soul. Henry Marion Howe, before whom the dust of the controversy loomed like a giant Afrite still defying attack, devoted his life thenceforth to the mighty conundrum, What is steel?"

In 1889 appeared in book form his "Metallurgy of Steel" after running serially in *Engineering and Mining Journal*. Let Dr. Howe's associate, Bradley Stoughton, tell of its influence:



HENRY MARION HOWE

"Before Howe wrote his great book, 'The Metallurgy of Steel,' steel making was a practice rather than a science, a series of operations producing material whose quality was sometimes uncertain and whose defects were not understood or explainable. The science of metallography was in its infancy; the use of the microscope in steel laboratories was scarcely heard of. This monumental book, in more ways than one marks an epoch in the history of steel metallurgy; it collected and collated all the valuable information in English, French and German. So thoroughly and so comprehensively had Howe performed the task that the previous literature of steel became of secondary importance, scarcely necessary for reference, because its most important data were included in this one concise volume.

HOWE'S LEADERSHIP RECOGNIZED INTERNATIONALLY

"From that time the leadership of Howe in the scientific and literary development of the metallurgy, metallography, heat-treatment and physical properties of iron and steel was recognized internationally. He was possessed of the qualities which eminently fitted him for this leadership. Gifted with a tact, a charm of personality as a presiding officer, an excellent speaking knowledge of French and German, he stimulated his audiences and brought out an active debate in a convention in any language; no one in this field had a command of the English language comparable with his; he developed clarity of expression which enabled him to clothe his thoughts in language that could be readily understood; his devotion to the truth was single minded and predominant; he was not only an able investigator and interpreter but he was an organizer of research to produce the most effective results from the experiments of himself and those working under or with him. He did not waste time with experiments, because he had students available to do the manual work; he did not duplicate work which had already been done, but he preceded each research with careful study of the information already available; he sought to investigate first those problems which stood in the way of progress, which were needed to fill in the gaps of knowledge, or whose solution would most enlarge our field of vision; he planned the work in advance; he did not tolerate a haphazard experimentation; he worked with a desire to reach a definite goal by the shortest possible method; he did not build his bridge without designs and calculations, but rather he prepared in advance in order that each step might count."

HIS MASTERLY WORK ON THE METALLOGRAPHY OF STEEL AND CAST IRON

All these labors were to be collected and interpreted in a series of monographs. Only one of them has been completed, "The Metallography of Steel and Cast Iron," appearing in 1916. This book is not a text-book, repeating what is generally accepted already. Covering the field in which others have meritoriously labored, it propounds, suggests and prophesies new truth and new views of truth. It is a product of the two kinds of genius, the genius which consists in an infinite capacity for taking pains, and the genius which with happy intuition surveys, divines, co-ordinates and interprets the cosmos in the chaos. It was hailed by scientists everywhere. Thus Sauveur:

"Prof. Howe, in his masterly book, 'The Metallography of Steel and Cast Iron,' reviews exhaustively and examines critically, as he alone can do, every view at all worthy of recognition, dealing with the subject he covers.

I believe that any responsible author who has ever expressed a reasonable opinion on any subject dealing with the metallography of iron and steel will find his views recorded and discussed in this book. Prof. Howe then proceeds to weigh with great fairness and extraordinary intelligence and lucidity the arguments or evidence supporting the different views, and draws his conclusions accordingly. His method is that of a mathematician solving a problem in which each factor is given its proper value. In this way Howe has rendered to metallurgists an inestimable service; and he alone could render it. Where most of us could see only chaos and obscurity, he is able to bring order, and to discover the light that, under his skillful manipulation, soon illuminates the darkest corners. . . .

"This, I think, is his greatest achievement—the marvelous co-ordination which he has brought into the science of metallography through his genius and his labor, tremendous in quantity, marvelous in lucidity. To him more than to any one else we owe the quick rejection of weak or ill-supported theories, in favor of the survival of the fittest—a process so necessary to the advance of any branch of human knowledge."

Completion of a series of such great works was undoubtedly prevented by the fact that during the Great War Dr. Howe acted as chairman of the Engineering Division of the National Research Council, giving his entire time and energy to the many problems in its charge. One of the many problems successfully solved was curing "haircracks" in airplane engine crankshafts. In this instance Dr. Howe applied the results of a study made by the Army and Navy Ordnance Departments on wastage in the manufacture of nickel steels of high transverse strength.

HIS SERVICE AS PRESIDENT A.S.T.M.

Dr. George K. Burgess also dwells upon the services rendered by Dr. Howe, during the four terms he acted as president of the American Society for Testing Materials:

"Dr. Howe always illuminated any subject which he considered and also took very active part in the discussion of any subject of interest to him and had a wonderful ability of expressing vividly and tritely the major facts as well as the details of any metallurgical problem, however recondite. His very logical mind and comprehensive grasp of the theoretical as well as the practical sides of questions relating to properties and testing of materials made him an exceedingly valuable leader in A.S.T.M. activities. He was always most frank and fearless, at the same time courteous and considerate, in expressing and maintaining his ideas in verbal discussion and in writings. I am certain that his balance, foresight and ability must have had a predominating and far-reaching influence in framing not only questions of Society policy but also in the development of technical and scientific problems. He with Professors Lanza and Merriman held each in his own field of engineering a unique place of dominance for many years in the A.S.T.M. councils. All three were professors, and each of them put the imprint of his personality into the formulation of its ideals. As far as metallurgy is concerned, the late Dr. Dudley and Professor Howe, one representing the practical use of specifications and the other more interested in development of correct concepts and securing progress by research, were easily the leading minds in the early days of the A.S.T.M."

Prof. William Campbell of Columbia University, who

was associated with Dr. Howe for many years, pays his tribute:

"In the death of Professor Howe this country has lost one of the great teachers. In other places various accounts of his distinguished services in his chosen profession have been given and also lists of his publications and of his well-earned honors, but here perhaps a word or two of appreciation of the man himself may not be out of place.

"Those of us who had the privilege of attending his courses or working with him in his laboratory or even only hearing him deliver one of his numerous contributions to science have been struck with his remarkable clearness of thought and of expression as well as his keen penetration and masterly interpretation of results. Yet with all his brilliance of mind he was sympathetic and patient with those of his associates less happily endowed. And his patience was that of Job.

"In the lecture room his modesty seemed to increase as his reputation became greater. He seldom, if ever, referred to his own contributions, but always gave credit to others, even where he himself had done all the planning. His method of presentation was so simple and so logical and his illustrations so homely that the dullest of us could not help but understand him, with the result that his courses seemed to be the easiest in the school.

"In the laboratory his kindly personality and fatherly interest in us all made him beloved by everyone. He spared no pains in training his men to do research in the scientific, orderly manner, for he had no respect for the old cookbook methods.

"Particularly were his characteristics noticeable in guiding us in our research. An indefatigable worker himself and of great painstaking in systematizing and planning work, yet he was never intolerant or sharply critical when things did not turn out satisfactorily because his advice had not always been followed. 'Try again' was his motto and when the work was done his praise and appreciation well repaid for all.

AIDED IMPECUNIOUS STUDENTS DELICATELY

"Another side of his character known to but few was his sympathy for the student who had to work his way. He constantly made opportunities for such a man to make a little extra money and he was always on the alert to see that such opportunities came his way. On more than one occasion where the offer of actual money would have hurt a sensitive person, Professor Howe thought up some research that needed doing and which at some future time might have some technical value and therefore ought to be paid for, and it was paid for generously.

"In spite of his busy life, for he worked himself to the limit, he found time to have his students home to lunch and dinner and then talking shop was barred. And yet we all came away feeling we had had a very pleasant time and rather proud of ourselves that we had been able to discourse so fluently and so brilliantly on all kinds of subjects—a thing which had never happened to us before."

W. P. Barba, a friend of Dr. Howe for many years and who collaborated with him in the preparation of the recently published article on "Acid Open-Hearth Practice in the Making of Fine Steels," writes:

"The passing of Dr. Henry Marion Howe creates an irreparable loss to the philosophic and practical consideration of the making of the utmost progress in the production of quality products in the iron and steel industry. Dr. Howe's rare insight into, first, the practice, and then the philosophy surrounding the practice

of this manufacture was so deep and wide that the writer can think of no one at present prepared to step into the place vacated by Dr. Howe.

"His many publications, accurately collecting and compiling practical data, deducing therefrom the correct theories so often developed, first, through practice and then disseminating so freely and fully the correct reasoning from this observed practice, furnished to the world of iron and steel a medium of full and correct thought which has so far been unmatched by the work of any other observer.

"Dr. Howe's unflinching courtesy, unflagging energy and immense industry were directed, for more than one generation, to the end that the practice of America first and of the world in general should be correctly guided, so that the practical results, coming through the many establishments engaged in the manufacture of these products, should be of maximum benefit.

"Dr. Howe will be missed by his many friends, by his thousands of admirers and disciples, and the writer hopes that the followers of Dr. Howe will pattern after his most meritorious example."

Corrosion Tests of Chromium Steels

It appears from the series of tests which the U. S. Bureau of Standards has carried out upon the corrosion of chromium steel that the behavior of the material when subjected to the acid test is not a sure criterion of its resistance to atmospheric corrosion. Of all the alloys examined, a high nickel-chromium steel, invar, pure iron and medium carbon steel (very slowly cooled from a high temperature) were the most resistant to hydrochloric acid as measured by the loss of weight per unit area per day. High-chromium steels, for example, containing 13.7 per cent Cr and 0.29 per cent C, were found to be attacked by acid very much more readily. However, when the same specimens were subjected to a weathering test, consisting of a partial immersion in water and exposure to the air, the order of resistance was almost completely reversed. The high-chromium steels were the ones to withstand the treatment best, the low-chromium ones and the pure iron showing rust spots early in the test. The combination of both nickel and chromium appears to make the steel resistant to both acid and weather attack. In general, the steels which were quenched were found to resist corrosion better than the same material in the annealed state, but the differences found were much less than the differences resulting from composition changes, thus indicating that composition rather than treatment should receive primary consideration. Additional results will not be ready for some time.

Spectroscopic Analysis of Bronzes

The Bureau of Standards, Washington, D. C., has completed the examination of five bronzes for impurities with the purpose of establishing the spectrographic method for quantitative estimation of small amounts of aluminum and silicon which are detrimental in bronze or brass castings. The method is simple, successful and sufficiently accurate. A report on this practical application of spectrum analysis was presented at the Non-Ferrous Metals Committee meeting on April 24, and a paper entitled "Spectrum Analysis in an Industrial Laboratory" was read before the Institute of Metals Division, February, 1922, by Messrs. Bassett and Davis, of the American Brass Co.

Effect of Sulphur on Rivet Steel

Maximum Sulphur Now Allowed (0.045 Per Cent) Is at Least 0.01 Per Cent Below the Quantity Where Sulphur Will Damage the Strength of Well-Made Rivet Steel, as Far as Its Performance Can Be Predicted by Standard Tests

By ERNEST E. THUM

A "PRELIMINARY REPORT of the Joint Committee on Investigation of Phosphorus and Sulphur in Steel" has just been issued as a preprint of a paper to be presented before the American Society for Testing Materials, Atlantic City, June 28. The text merely recounts the number and kinds of tests, and presents thirty-three diagrams summarizing the results. Complete publication will ultimately be made as a Bureau of Standards technologic paper and presumably will contain all information available on the method of steel making and rolling, numerical results of tests, photographs of fractures and microscopic studies of structure. "While the Joint Committee has received all the test data in this investigation, it prefers to defer any extended discussion of the results and the drawing and publishing of formal conclusions therefrom." This attitude of the committee is unfortunate, for there is a vast amount of data contained in the pamphlet (over 5,000 physical tests and 1,000 chemical analyses were made) and few metallurgists will have the time necessary to analyze it and seek out its meaning. It must therefore be understood that only the diagrams presented herewith are vouched for by the committee—the tables (except Table I), the discussion and the conclusions have been deduced by the present writer.

STEELS USED

Thirteen 75-ton heats of basic open-hearth steel varying in sulphur from 0.03 to 0.08 per cent, and one with 0.18 per cent sulphur, were made and rolled into 1-in. bars by the Carnegie Steel Co. This sulphur is

uniform results shown in Table I. No nickel or chromium was found. Heat F is high in both manganese and carbon; this composition is unmistakably reflected in the physical tests, and in view of its very low sulphur contents, it would have been proper to omit this steel from the series. This done, the composition of the various materials may be regarded as: Carbon, 0.11 per cent; manganese, 0.43 per cent; phosphorus, 0.01 per cent.

Even after eliminating heat F, manganese, unfortunately, varies from 0.35 to 0.51, and tends to go up with the sulphur. Therefore some of the effects of sulphur may be masked by this other element, and in the discussion which follows it should always be remembered that $\% S + 0.40 = \% Mn$.

TESTS ON RIVETS

Two hundred rivets were made of each steel and tested in various ways. Twenty rivets from each test were upset two-thirds their length, ten hot and ten cold, with no failures. Ten hot rivets of each heat had their heads flattened to $2\frac{1}{2}$ times the shank diameter, and six more from each heat had their shanks flattened hot to $\frac{1}{2}$ in. at the edges without failures. Eight cold rivets from each heat were bent flat upon themselves in the condition as received, without failures. Eight rivets from each heat were bent flat upon themselves after quenching from 940 deg. C. (1,725 deg. F.); the only failures recorded were in the 0.18 S steel.

The conclusion is that sulphur up to 0.10 per cent in well-made rivet steel does not affect the hot or cold shortness. All the ingots and billets rolled satisfactorily, with exception of heat P, which cracked slightly in blooming.

INTERPRETATION OF CURVES

To aid in fixing the indication of the test results, smooth curves (in most cases straight lines) were penciled which approximated the general trend of the somewhat jagged lines given in the report and reproduced here. Values for 0.03, 0.06 and 0.10 per cent sulphur were then scaled from this tentative median.

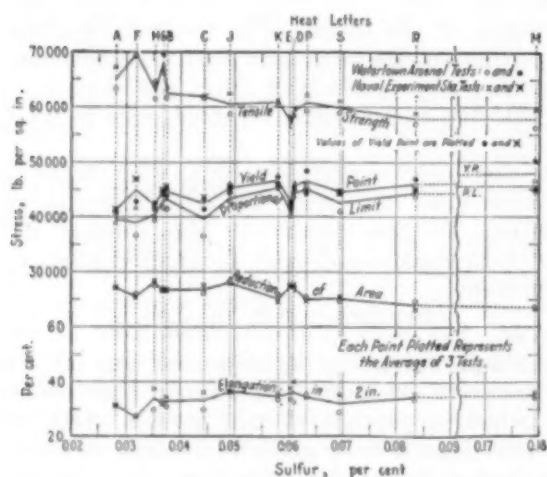
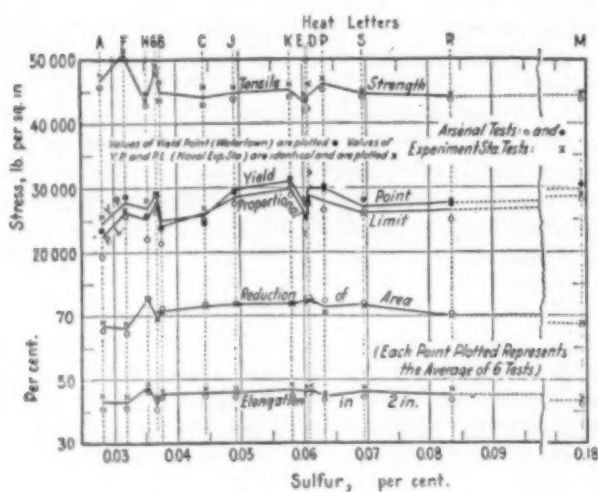
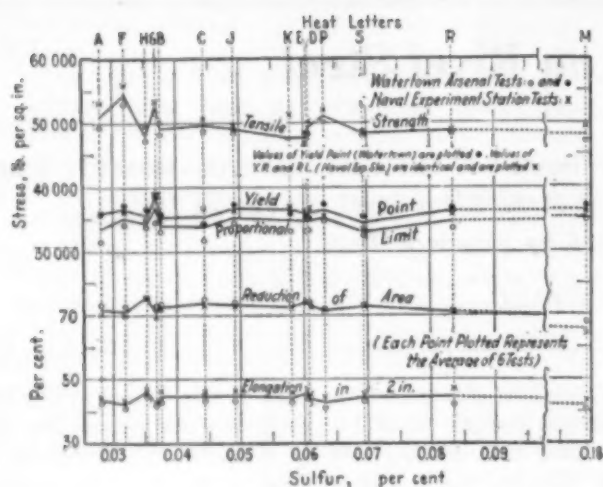
It may as well be recognized immediately that such a plan would involve a large personal factor, and if some of the readers of the report will take the trouble to do it for themselves, perhaps their results would vary several per cent from those given in the table. However, in this particular attempt, sample F was disregarded altogether, and samples A and G somewhat minimized on account of their high carbon. Sample P has (comparatively speaking) very high phosphorus. E and D, being identical in sulphur, were given special weight. A sincere effort to avoid undue influence of the single point out at 0.18 per cent sulphur was also made.

TABLE I—AVERAGE CHEMICAL COMPOSITIONS, WITH MEAN DIVERGENCES

Each value is the average of separate analyses on 14 samples from each heat. The heats are arranged in the order of increasing sulphur contents.

Heat Letter	Ingot Hot or Cold	Sulphur, Per Cent	Carbon, Per Cent	Manganese, Per Cent	Phosphorus, Per Cent
A...	Cold	.0282 * .0015	.136 * .0037	.426 * .021	.0062 * .0005
F...	Hot	.0317 * .0016	.149 * .0043	.642 * .0075	.0082 * .0017
H...	Hot	.0355 * .0015	.110 * .0025	.362 * .0037	.0055 * .0015
G...	Hot	.0367 * .0020	.137 * .0037	.466 * .0037	.0085 * .0015
B...	Cold	.0377 * .0009	.112 * .0080	.392 * .012	.0082 * .0009
C...	Cold	.0444 * .0026	.107 * .0075	.455 * .005	.0082 * .0012
J...	Hot	.0492 * .0016	.107 * .0037	.355 * .0062	.0062 * .0027
K...	Hot	.0580 * .0030	.115 * .0050	.411 * .0087	.0105 * .0025
E...	Cold	.0606 * .0033	.104 * .0037	.457 * .006	.0105 * .0010
D...	Cold	.0608 * .0012	.094 * .0040	.385 * .015	.0127 * .0020
P...	Hot	.0633 * .0018	.116 * .0037	.432 * .005	.0240 * .0030
S...	Hot	.0695 * .0028	.104 * .0043	.420 * .020	.0117 * .0003
R...	Hot	.0834 * .0033	.106 * .0037	.472 * .0025	.0112 * .0030
M...	Hot	.1793 * .0027	.106 * .0037	.512 * .0075	.0060 * .0030

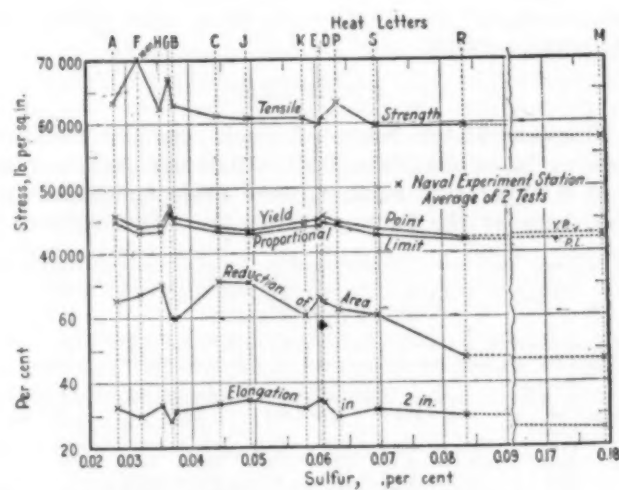
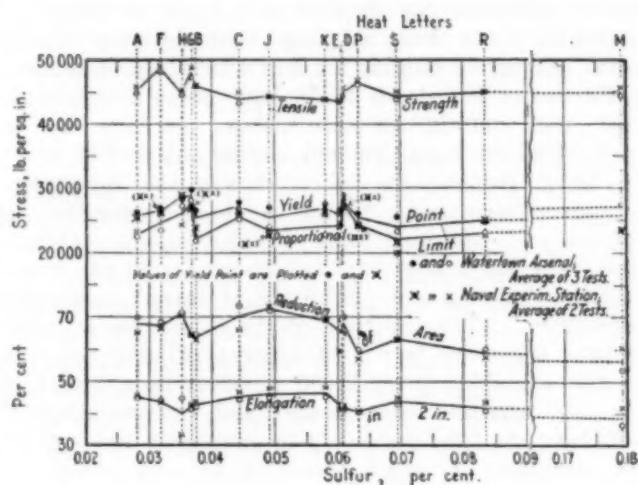
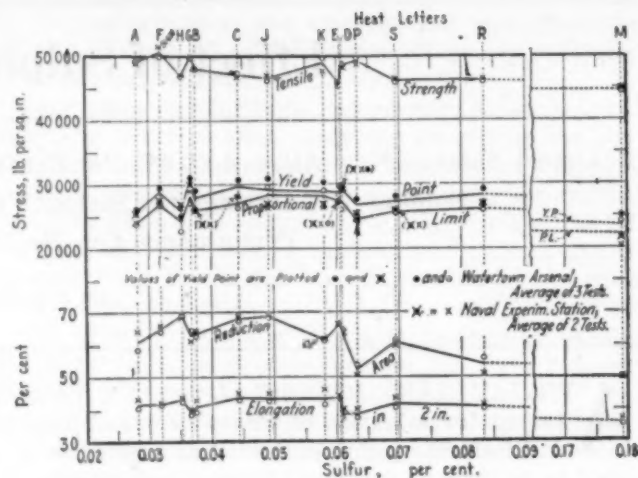
"residual"—i.e., due to sulphur in the charge and fuel and not to additions of sulphides after melting. Physical and chemical tests on the material were made at Watertown Arsenal and at the U. S. Naval Engineering Experiment Station, Annapolis. Twelve complete analyses were made on each heat, giving the very



1 in. Rivet Bars
Fig. 1—As received.
Fig. 2—Annealed at 940 deg. C.
Fig. 3—Quenched from 940 deg. C.

TENSION TEST

Inspection of Fig. 1 from the report and Table II by the present writer indicates that in this series of rivet bars sulphur up to 0.10 certainly (and perhaps up to 0.18) has practically no effect on the tensile properties. The curves are nearly horizontal. Results as determined are quite uniform; variations from a straight line at samples F, G and P may be ascribed



FIGS. 1 TO 6—TENSILE TESTS

5 1/2 x 1 in. Flats
Fig. 4—As received.
Fig. 5—Annealed at 940 deg. C.
Fig. 6—Quenched from 940 deg. C.

to irregularities in chemical composition (high manganese, carbon and phosphorus respectively). These facts may be summarized in the statement that:

A basic open-hearth rivet steel with composition: C 0.11, Mn 0.43, P 0.01 and S 0.03 has the following tensile properties when tested in 1-in. bars, as received from the mill: Tensile strength, 49,500 lb. per sq. in.; yield point, 36,000 lb. per sq. in.; reduction in area, 72 per cent; elongation in 2 in., 44 per cent. Each addi-

tional 0.01 per cent S up to 0.10 decreases the tensile strength 200 lb. per sq.in. and increases the yield point 100 lb. per sq.in.

One-inch bars tested transversely, in the condition as received (Fig. 4), have yield point and reduction in area much lowered, a symptom of transverse weakness independent of the sulphur content. Reduction in area is further affected markedly as the sulphur goes up, although all the tensile properties seem to show a slight downward trend with increasing sulphur.

After annealing for 30 minutes at 925 to 950 deg. C. and furnace cooling, the greatest change in tensile properties from those given in the 1-in. rivet bars as received is a pronounced drop in the yield point. Fig. 2 shows that the properties plot against sulphur content in what is nearly a horizontal straight line except that the yield point seems to increase slightly with increasing sulphur. The evidence seems to be that:

Annealing these bars for 30 minutes at 925 to 950 deg. C. and furnace cooling lowers the tensile strength 4,000 lb. per sq.in., the yield point 8,000 lb. per sq.in., but does not affect the reduction in area or elongation.

Transverse properties are substantially unaffected by annealing.

QUENCHING ACCENTUATES EFFECT OF SULPHUR

Quenching in water after 30 minutes or 1 hour at 925 to 950 deg. C. increases the tensile strength and yield point of 1-in. rivet bars and 1-in. slabs (transversely) very materially, as can be seen from an inspection of Table II and Figs. 3 and 6. Elongation is

TABLE II—TENSILE TESTS

	1-In. Rivet Bars; Tested Parallel to Rolling			5½x1-In. Flats; Tested Perpendicular to Rolling		
	0.03S	0.06S	0.10S	0.03S	0.06S	0.10S
As received.....	49,500	49,000	48,000	48,500	47,200	45,500
Tensile strength.....	36,000	36,200	36,500	26,000	29,000	27,000
Yield point.....	73	73	71	67	64	50
Reduction in area.....	44	44	44	42	41	38
Elongation.....						
Annealed at 940 deg. C.						
Tensile strength.....	45,200	45,000	44,700	45,200	44,800	44,000
Yield point.....	26,000	28,400	29,200	26,900	26,500	26,000
Reduction in area.....	71	74	70	67	68	58
Elongation.....	45	46	45	44	43	41
Quenched from 940 deg. C.						
Tensile strength.....	63,600	59,200	56,000	63,000	61,000	58,500
Yield point.....	42,700	45,000	47,000	45,500	44,500	43,500
Reduction in area.....	75	73	70	67	65	46
Elongation.....	32	35	37	32	33	31

reduced correspondingly. The curves for reduction in area of quenched transverse specimens (Fig. 6) drops with high sulphurs to a much more pronounced extent than any of the previous ones.

It may now be desirable to review the data on tensile properties of rivet steel containing sulphur up to 10 points, as illustrated by Figs. 1 to 6 and summarized in Table II.

In all cases the tensile strength decreases slightly and uniformly with increasing sulphur. In nearly all cases the yield point increases slightly with increasing sulphur. These tendencies are markedly accentuated by quenching.

Curves for reduction of area always show a maximum at 0.04 to 0.06 per cent S, much more pronounced in the transverse specimens. (This might bear out the contention of certain steel makers that it is more damaging to "force" a heat of steel to remove sulphur than to leave it in, were it not for the fact that the manganese curve shows a definite minimum in the same region.) Heat-treatment has a singularly small effect on reduction of area.

TABLE III—IMPACT TESTS

	1-In. Rivet Bar; Broken Across the Fiber			5½x1-In. Flats, Broken Impact Parallel to Rolling			With the Fiber Broken Impact Perpendicular to Rolling		
	0.03S	0.06S	0.10S	0.03S	0.06S	0.10S	0.03S	0.06S	0.10S
As received.....	54	53	40	26	22	16	18	16	13
Izod.....	40	39	38	40	39	38	39	38	36
Charpy Impact shear.....	38 (7)	42	40 (7)	12	11	10	15	14	12
Annealed at 940 deg. C.	8.5	11	10	12	11	10	15	14	12
Izod.....	38	38	37	42	40	38	40	38	36
Charpy Impact shear.....	112 (7)	112 (7)	90 (7)	40 (7)	27 (7)	17 (7)	40 (7)	27 (7)	17 (7)
Quenched from 940 deg. C.	62	54	43	40 (7)	27 (7)	17 (7)	40 (7)	27 (7)	17 (7)
Izod.....	50	47	41	50	46	41	47	45	42
Charpy Impact shear.....									

Sulphur content up to 0.10 per cent seems to have little influence on elongation.

IMPACT STRENGTHS

A maximum just noted in the curves for reduction in area reappears more pronouncedly in the curves for Izod and Charpy impact on rivet bars tested in the condition as received, Fig. 7. In these curves for the first time appears an unmistakable deterioration in properties when sulphur goes above 0.06 per cent. Minor fluctuations are generally paralleled each to each, in Izod and Charpy tests. Impact shear on an unnotched specimen, on the other hand, is quite straight, and almost horizontal.

Ambiguous wording in Figs. 10 to 12 referring to the direction of fracture on transverse tests may be removed by a glance at Fig. 13. All transverse impact fractures are therefore fractures "with the fiber." Comparing the curves for impact shear, it appears immaterial whether an unnotched specimen is broken with or across the direction of rolling—the work expended is substantially the same. (It may be debatable whether such results, in view of wide variations in notched bars broken in Charpy and Izod machines, denote a uniform material or an insensitive testing method.) Charpy tests transverse and "with impact in direction of long dimension of slab" break with less than half the work it requires for rivet bars, and the effect of high sulphur is even more apparent than before, dropping from 26 ft.-lb. for 0.03 S to 16 ft.-lb. for 0.10 S.

ANNEALING DESTROYS IMPACT PROPERTIES

Extraordinary variation in Izod impact values is shown after annealing rivet bars 30 minutes at 940 deg. C. and cooling in the furnace. Heats A and H, whose other properties do not vary widely, have Izod impacts of 26 and 47 respectively, while E and D, whose chemical composition except for manganese is almost identical, give results of 34 and 66. These are the average of eight tests. Charpy impact results are much more regular, but are surprisingly low—about 10 ft.-lb.—and apparently unaffected by sulphur. Impact shear, as before, is featureless and quite steady at about 38 ft.-lb.

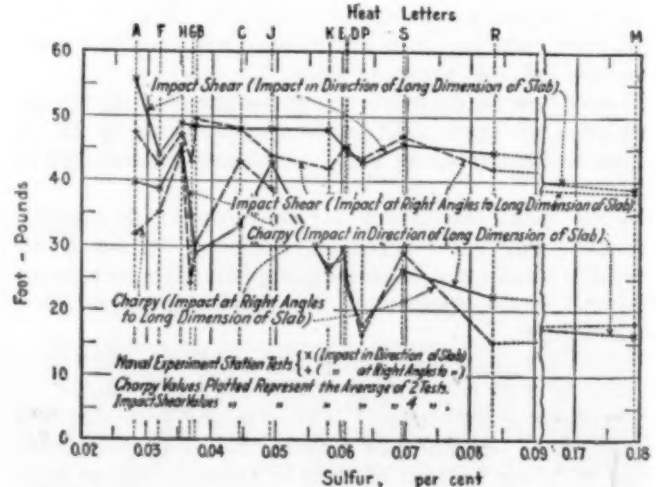
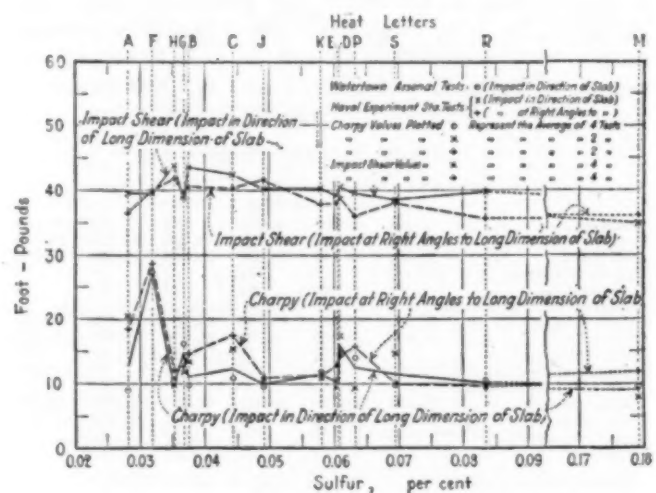
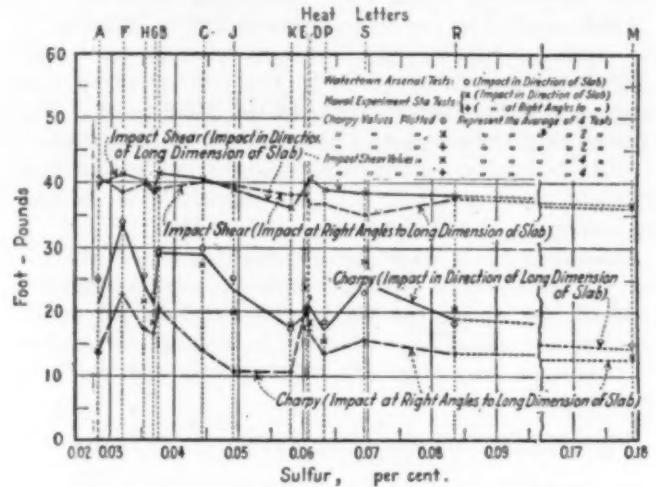
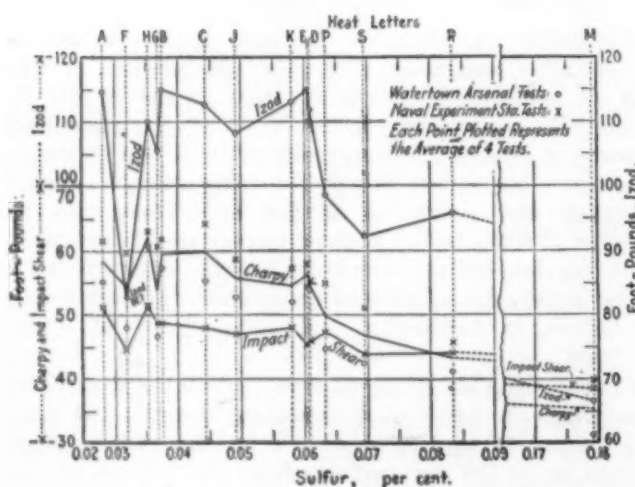
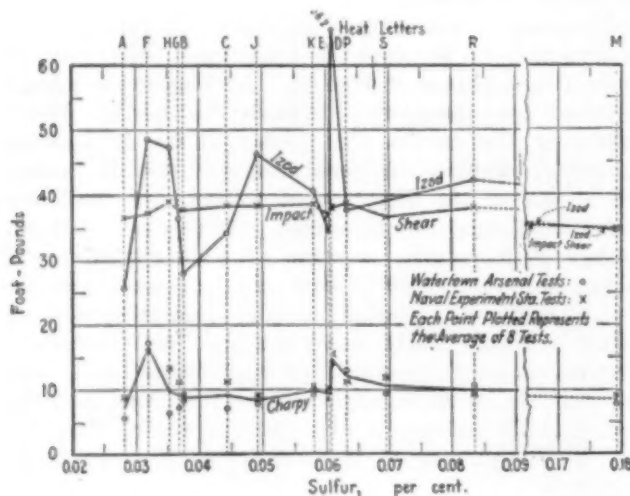
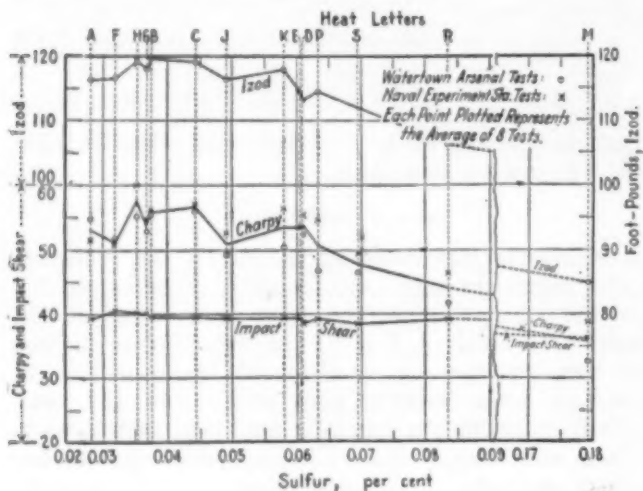
Charpy tests on annealed flats are confused and not consistent. It seems that annealing reverses the relative impact strengths, when hit on the sawed cross-section or on the flat surface, from that shown in the bars as received.

Quenched rivet bars give Charpy and impact shear

¹Method described by D. J. McAdam, Jr., *Proceedings, A.S.T.M.*, vol. 16, Part II, p. 299 (1916).

values somewhat higher than the bar as received, and the bad effect of high sulphur is accentuated by quick cooling, as was the case in the tensile properties. Izod figures are quite erratic, as before, but eliminating the high-manganese, high-carbon heat F, the impact value of quenched bars containing up to 0.06 per cent sulphur remains reasonably constant at a little over 110 ft.-lb., whereupon it takes a sharp drop. Transverse tests on quenched flats are very confusing.

In review, it may be said that the effect of sulphur is unmistakably and strongly felt on the impact strength of rivet steel. Even one who pins his faith in the shearing strength of unnotched bars will recognize a definite if sometimes slight downward slope of all the curves with increasing sulphur content. Despite the violent fluctuations of some of the values for quenched specimens the Charpy and Izod tests magnify this downward tendency to a very marked extent. It



FIGS. 7 TO 12—IMPACT TESTS

1 in. Rivet Bars
Fig. 7—As received.
Fig. 8—Annealed at 940 deg. C.
Fig. 9—Quenched from 940 deg. C.

5 1/2 x 1 in. Flats
Fig. 10—As received.
Fig. 11—Annealed at 940 deg. C.
Fig. 12—Quenched from 940 deg. C.

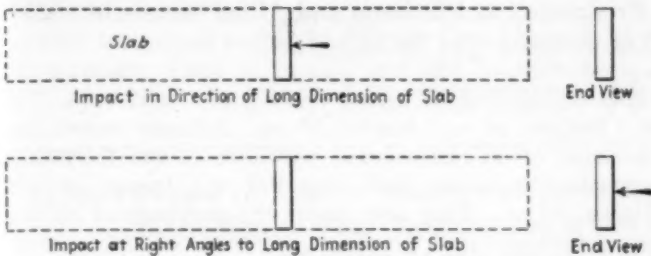


FIG. 13—METHOD OF TESTING TRANSVERSE IMPACT SPECIMENS. ARROW SHOWS DIRECTION IN WHICH HAMMER MOVES

may be contrary to expectation to find low impact strength in annealed bars and high impact strength in quenched bars. Unfortunately no metallographic studies are yet available to indicate whether or not low impact strength is associated with immoderate grain growth.

HARDNESS

Sulphur has practically no effect on the hardness, as is seen in Fig. 14 and Table IV. A slight trough in the curves at 0.04 to 0.06 per cent S is probably due to

TABLE IV—HARDNESS OF RIVET BARS

	By Brinell Ball			By Scleroscope		
	0.03S	0.06S	0.10S	0.03S	0.06S	0.10S
As received.....	97	94	94	17	17	17
Annealed at 940 deg. C.....	87	87	87	15	16	17
Quenched from 940 deg. C.....	138	127	130	21	19	20

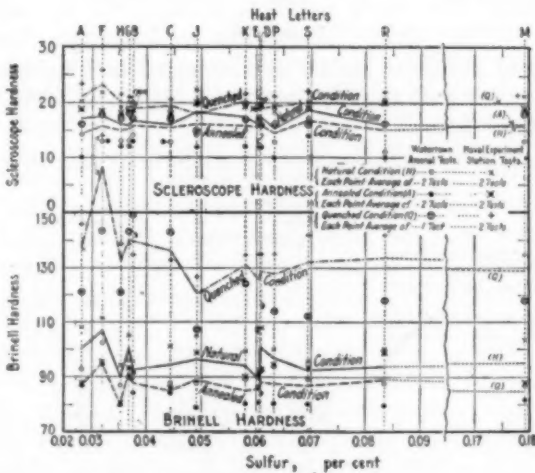


FIG. 14—HARDNESS TESTS

low contents of manganese, since the hardness curves parallel the amount of manganese in the samples fairly closely. It is rather remarkable that the steels delivered to Annapolis are consistently and substantially harder than those sent to Watertown (an average difference of 11 Brinell units is recorded in the bars as received).

TORSION

Torsional properties of 1-in. rivet bars are very slightly affected by sulphur up to 0.10, if at all. (See Table V.) Properties are satisfactorily approximated by a straight line, nearly horizontal. Curves for "angle of twist at break" are so jagged that it would be unsafe to draw many conclusions from the pronounced bump at 0.05 to 0.06 per cent sulphur; in fact a smoother

TABLE V—TORSIONAL PROPERTIES OF 1-IN. RIVET BARS.

	0.03S	0.06S	0.10S
As received.....	0.038	0.068	0.108
Stress at maximum torque.....	47,500	46,300	45,000
Stress at proportional limit.....	20,500	20,500	20,500
Angle of twist at break.....	31	36.5	30
Angle of twist at proportional limit.....	16.5	14.5	16.5
Annealed at 940 deg. C.....			
Stress at maximum torque.....	43,700	43,300	42,800
Stress at proportional limit.....	14,200	15,000	16,000
Angle of twist at break.....	11	24	15
Angle of twist at proportional limit.....	10	11	12
Quenched from 940 deg. C.....			
Stress at maximum torque.....	56,800	54,000	53,000
Stress at proportional limit.....	21,000	21,500	22,300
Angle of twist at break.....	33.5	32.5	29
Angle of twist at proportional limit.....	18	19.5	17

curve may be had by plotting against manganese content rather than against sulphur.

STATIC SHEAR OF RIVETS AND RIVETED JOINTS

In view of the use to which rivets are ordinarily put in structures of magnitude, especial attention should be given to the tests on shearing strength of rivet bars and riveted joints, shown by the committee in Fig. 15, and summarized by the writer in Table VI. Single-shear joints were made by riveting 1/2-in. chromium-nickel steel plates with rivets from each heat, and then pulled apart in a testing machine; sixteen tests from each heat were made. Similarly ten tests from each heat were made on double-shear joints. None of these joints is sketched in the preprint.

As shown by the curves in Fig. 15, the shearing

TABLE VI—SHEARING STRENGTHS

	1-In. Rivet Bars			5/16x1-In. Flats Sheared Along the Grain		
	0.03S	0.06S	0.10S	0.03S	0.06S	0.10S
As received.....	37,500	36,600	35,600	39,000	38,200	37,000
Annealed at 940 deg. C.....	35,000	34,200	33,200	37,800	37,200	36,400
Quenched from 940 deg. C.....	50,500	47,200	46,700	47,600	46,500	45,000
Riveted Joints						
Single shear.....	39,200	38,000	36,500			
Double shear.....	37,800	37,200	36,500			

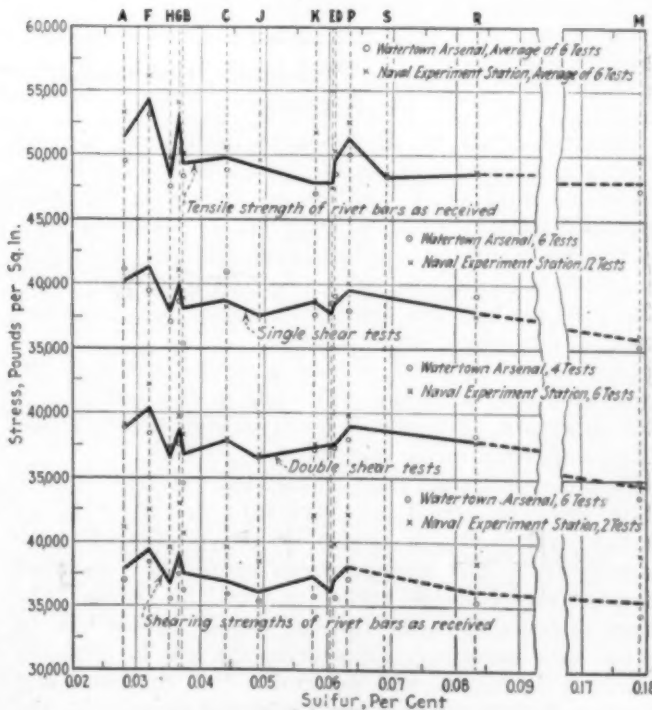


FIG. 15—SHEARING TESTS ON RIVETED JOINTS IN SINGLE AND DOUBLE SHEAR, AND ON THE RIVET BARS AS RECEIVED

strength of the rivet bar as received is almost exactly parallel to those derived from riveted joints. It appears therefore that the normal processes of making and driving a $\frac{1}{2}$ -in. rivet does not materially alter the properties as determined in the original bar, as far as shearing strength in the completed joint is concerned, when tested under static loads. We may conclude that:

The static strength of rivets in single- or double-shear is closely approximated by the shearing strength of the rivet bar, and equals 38,200 lb. per sq.in. for basic open-hearth steel containing 0.11 C, 0.43 Mn, 0.01 P and 0.03 S. Each 0.01 per cent sulphur decreases this value 300 lb. per sq.in.

CONCLUSION

About the only recommendation the committee made in this preliminary report is that a comparative study of the various curves might be useful. Following that suggestion, I have taken the liberty of adding the curve for tensile strength of the rivet bars as received to Fig. 15. It shows that whatever may be the various factors which cause one of these steels to be slightly different from another, they seem to have a net effect on the tensile test, as they have on a rivet driven tightly in place. As far as the static properties of rivet steel are concerned the tensile strength gives as much information as any of the others.

Impact properties, measuring toughness, assuredly should be high in a rivet. Much debate may be had from proponents of certain impact machines, and from opponents of all of them. However that may be, the present series of rivet bars is so balanced in chemical composition, manufacture and treatment that the impact values are not materially lowered until sulphur passes 0.06 per cent. Indeed, indiscreet heating may do ten times as much damage as 0.10 per cent sulphur.

The maximum sulphur now allowed in structural steel rivets (0.045 per cent) is at least 0.01 per cent below the point where sulphur will damage the strength of a well-made rivet steel, as far as its performance can be predicted by known tests.

Crystal Structures of Vanadium, Germanium and Graphite

Albert W. Hull, of the Research Laboratory, General Electric Co., read a paper on the above subject before the recent meeting of the Physical Society at Washington. Vanadium has been analyzed in powdered form by the X-ray diffraction photograph method. Its lattice is a body-centered cube with side 3.04 Angstrom units. The distance between nearest atoms is 2.63 Angstrom units, and the ideal density 5.96.

Germanium is found to have a crystal structure the same as that of diamond. The side of the unit cube is 5.63 Angstrom units, the distance between nearest atoms 1.218 Angstrom units, and the density 5.36.

New and more accurate diffraction patterns of graphite have confirmed the structure described in an earlier paper—viz., a lattice of the hexagonal close-packed type. The measurements cannot be reconciled with the rhombohedral structure found by Debye. The exact distance between nearest planes cannot yet be stated with certainty. Measurements are in progress which, it is hoped, will determine this distance, and whether the three bonds are all in one plane, with the fourth bond at right angles, or whether all four bonds are symmetrically disposed as in diamond.

Production of Platinum and Allied Metals in 1921

Miners report to the United States Geological Survey a production of 538 troy ounces of crude platinum in 1921, distributed by states as follows: California, 387 oz.; Oregon, 83 oz.; Alaska, 65 oz. Refiners report the purchase of domestic crude platinum in the following quantities by states: California, 847 oz.; Oregon, 96 oz.; Alaska, 78 oz. They also report the purchase of 56,654 oz. of foreign crude platinum, of which 55,286 oz. was from Colombia, South America; 63 oz. from Canada, and 1,286 oz. of Russian origin.

Refiners report an increase of over 26 per cent in the recovery of new platinum metals in 1921, as compared with 1920. The greatest increase was in platinum. Of the metals recovered in 1921 by refiners, about 4,800 oz. was obtained from domestic material.

NEW PLATINUM METALS RECOVERED BY REFINERS, IN TROY OUNCES

	Platinum	Palladium	Iridium	Osmiridium	Other	Total
1917	33,009	4,779	210	833	.....	38,831
1918	54,399	4,024	465	539	326	59,753
1919	40,220	3,807	401	403	279	45,109
1920	36,015	4,309	418	409	393	41,544
1921	51,791	2,686	286	581	1,026	56,370

SECONDARY PLATINUM

Platinum metals recovered from scrap and other old material form an important part of the supply. The total quantity recovered in 1921, 45,794 oz., is about 20 per cent less than that recovered in 1920,

SECONDARY PLATINUM METALS RECOVERED BY REFINERS, IN TROY OUNCES

	Platinum	Palladium	Iridium	Total
1917	59,007	3,347	9,832	72,186
1918	40,378	1,795	3,410	45,583
1919	54,545	3,467	3,504	61,516
1920	51,255	3,100	3,355	57,710
1921	39,131	4,887	1,776	45,794

IMPORTS

Refined platinum metals are imported in considerable quantity, as well as crude platinum, which is bought by domestic refiners.

PLATINUM METALS IMPORTED FOR CONSUMPTION IN THE UNITED STATES, 1920-1921

	1920		1921	
	Quantity (Troy Oz.)	Value	Quantity (Troy Oz.)	Value
Platinum or crude platinum and unmanufactured products, ingots, bars, sheets, wire,	80,955	\$8,474,499	61,941	\$4,135,235
Platinum manufactured products, vases, retorts, etc.	781	* 94,408	76	† 28,524
Iridium	4,718	726,502	1,345	277,597
Osmiridium	4,473	450,241	2,603	296,277
Osmium	593	39,517	161	13,239
Palladium	6,944	612,248	11,348	629,965
Rhodium	2,053	217,385	609	53,359
Ruthenium	29	2,640	152	4,268
	100,546	10,617,440	78,235	5,438,464

* Includes wire to the value of \$5,433 imported under 15 per cent duty, quantity not given, and "all other" to the value of \$10,278 imported under 50 per cent duty, quantity not given.

† Includes 13 oz. wire, valued at \$14,404, imported under 15 per cent duty, and "all other" to the value of \$6,947, quantity not given.

CONSUMPTION

The total consumption of platinum metals in the United States in 1921 was 176,148 troy ounces, an increase of about 25 per cent as compared with the consumption in 1920. Dentists and jewelers increased their use of platinum. The consumption of the chemical and electrical industries decreased.

CONSUMPTION OF PLATINUM IN THE UNITED STATES, 1920-1921, BY INDUSTRIES, IN TROY OUNCES

Industry	Platinum	Iridium	Palladium	Total	Percentage of Total
Chemical	12,273	34	45	12,352	7.02
Electrical	20,574	1,003	7,626	29,203	16.58
Dental	13,181	75	8,501	21,757	12.35
Jewelry	101,258	2,367	1,265	104,890	59.55
Miscellaneous	3,791	3,938	217	7,946	4.50
	151,077	7,417	17,654	176,148	100.00

Studies in the Carbonization of Coal: The Mechanism of Coal Carbonization*

Critical Review of Current Theories of Secondary Carbonization Reactions — Interpretation of the Mechanism of Coal Carbonization in the Light of the Composition of a Commercial Low-Temperature Tar — A Theory of the Constitution of Coal

By JEROME J. MORGAN AND ROLAND P. SOULE

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IN A previous contribution a scheme was outlined for the ready examination of low-temperature coal tar, and by its means the characteristics of a commercial product were determined. Comparison with the composition of low-temperature tars produced on a small scale shows that the commercial tar represents a slightly more advanced stage of carbonization. It is thus possible in the present paper to present a new viewpoint on the much-disputed mechanism of the carbonization of coal, and to interpret distillation reactions in the light of the composition of this intermediate product. Finally, there is proposed briefly a theory of the constitution of coal which explains the composition of low-temperature tars.

Berthelot's classic theory¹ of the origin of ordinary coal tar held the field for many years after it was first advanced in 1866. Acetylene is formed, Berthelot stated, by the decomposition of such simple gases as methane in the volatile products from coal, and polymerizes immediately at high temperatures to form benzene, styrolene, naphthalene and other aromatic hydrocarbons. This theory has been rendered untenable, however, by experiments which have proved (1) that acetylene is not formed in any considerable quantity in the gaseous products of coal distilled at various temperatures, and that its reaction velocity of synthesis is not fast enough to account for this absence;² (3) that methane, ethane and propane do not yield acetylene as their principal decomposition products;³ and (3) that primary distillation products of relatively high molecular weight—i.e., low-temperature tars—are obtained in the carbonization of coal.

All modern theories of carbonization, therefore, acknowledge the important rôle played by low-temperature tars in the distillation of coal. While it is thus generally recognized that ordinary high-temperature (900-1,200 deg. C.) coal tar is formed by the decomposition of tar produced at lower temperatures (500-600 deg. C.), the mechanism of this decomposition⁴ is still a matter of lively dispute. No comprehensive

scheme has been advanced to account for more than relatively a small number of carbonization phenomena. Investigators in general have confined themselves to limited aspects of the problem, and have sought to lay emphasis upon certain predominating reactions. Thus, the origin of the aromatic hydrocarbons of ordinary tar has been variously attributed to:

- (1) Decomposition of the hydrocarbons of low-temperature tar to simple compounds, which subsequently undergo pyrogenetic syntheses (Jones, Bone, *et al.*).
- (2) Hydrogenation and dealkylation of the phenols of low-temperature tar (Schulze, Fischer and Schrader).
- (3) Dehydrogenation and dealkylation of the unsaturated hydrocarbons of low-temperature tar (Pictet).

The present investigation leads to evidence which supports in general the last two of these conceptions, and hence assigns to pyrogenetic syntheses a part of secondary importance. A brief review of the experimental data underlying these several carbonization theories is a necessary preliminary to the development of a more comprehensive and extended analysis of the phenomena of coal distillation.

THEORIES OF DECOMPOSITION OF LOW-TEMPERATURE HYDROCARBONS

Pyrogenetic Syntheses. Probably the most generally accepted theories of tar formation at present are those which postulate the decomposition of the primary tar to simple unsaturated hydrocarbons that condense subsequently to form aromatic hydrocarbons. Jones⁵ states that "the mechanism of the breaking down of low-temperature tar consists essentially in the decomposition of the naphthenes, paraffines and unsaturated hydrocarbons present in the low-temperature tar to form olefines of varying carbon content, which condense at higher temperatures to aromatic substances."

In arriving at this conclusion he passed low-temperature tar⁶ slowly through a tube filled with porous porcelain, and examined the gaseous products obtained at various temperatures between 550 and 800 deg. C. He stated that benzenoid hydrocarbons could be formed only to a limited extent⁷ by the elimination of hydrogen from the corresponding naphthenes, since members of the cyclohexane series break down principally by a scission of the ring with the formation of olefines, including butadiene, and of paraffines and hydrogen. The gaseous olefines were found to be at a maximum at 550 deg., and almost disappeared at 750 deg. This

*Part of a dissertation submitted by Roland P. Soule in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Faculty of Pure Science of Columbia University in the City of New York. For preceding parts see CHEM. & MET. ENG., vol. 26, Nos. 20 and 21, pp. 923 and 977, May 17 and 24, 1922.

¹Berthelot, *Ann. chim. phys.* [3], vol. 67, p. 53 (1863); [4], vol. 9, pp. 413, 455 (1866); [4], vol. 12, pp. 5, 122 (1867); [4], vol. 16, pp. 143, 148, 153, 162 (1869).

²M. J. Burgess and R. V. Wheeler, *J. Chem. Soc.*, vol. 97, p. 1917 (1910); vol. 99, p. 649 (1911); vol. 105, p. 131 (1914); A. H. Clark and R. V. Wheeler, *ibid.*, vol. 103, p. 1704 (1913).

³T. E. Thorpe and J. Young, *Proc. Roy. Soc.*, vol. 21, p. 184 (1873); H. E. Armstrong and A. K. Miller, *J. Chem. Soc.*, vol. 49, p. 74 (1886); F. Haber, *Ber.*, vol. 29, p. 2691 (1896); W. A. Bone and H. F. Coward, *J. Chem. Soc.*, vol. 93, p. 1197 (1908).

⁴For the analogous process of decomposition of the bitumen of shale to yield oil on distillation, R. H. McKee and E. E. Lyder, *J. Ind. Eng. Chem.*, vol. 13, pp. 613, 678 (1921); Arthur J. Franks, *CHEM. & MET. ENG.*, vol. 25, pp. 731, 778 (1921); C. W. Botkin, *ibid.*, vol. 24, p. 876 (1921); L. C. Karrick, *Chem. Age (N. Y.)*, vol. 30, p. 112 (1922).

⁵D. T. Jones, *J. Soc. Chem. Ind.*, vol. 36, p. 3 (1917).

⁶D. T. Jones and R. V. Wheeler, *J. Chem. Soc.*, vol. 105, p. 140 (1914).

⁷D. T. Jones, *J. Chem. Soc.*, vol. 107, p. 1582 (1915).

disappearance synchronized with the appearance of naphthalene, and immediately preceded a rapid increase in the evolution of hydrogen, which "must probably be attributed to the union of the aromatic molecules and to intramolecular ring closing."

Jones quotes the work of Staudinger¹¹ as an example of the polymerization of diolefines to aromatic substances. Moreover, Staudinger identified butadiene in the gas distilled from coal. Instances of its formation also from naphthenes, olefines, saturated hydrocarbons and petroleum vapors from cracking stills are also cited. "It is highly probable," Jones concludes, "that a necessary transition stage is the formation and condensation of olefines containing the conjugated double linkage $-\text{CH}:\text{CH}.\text{CH}:\text{CH}-$. Polynuclear aromatic substances are formed at 750 deg. and upward subsequent to the decomposition of the olefines." Jones, contrary to Pictet, regards phenols as primary products of coal distillation, "those of high-temperature tar being formed with certain changes from those of low-temperature tar. Much of the high-temperature pitch is formed by partial carbonization of the low-temperature pitch."

Bone,¹² from a study of the behavior of the simple hydrocarbons at temperatures between 500 and 1,200 deg. C., has elaborated this theory of olefine condensations. He introduces the new conception that the thermal decomposition of the hydrocarbons of low-temperature tar "involves the primary formation by dehydrogenation of the unsaturated residues CH_2 (two free bonds) and CH (three free bonds), which during a fugitive but really independent existence are free to interact with the surrounding gaseous medium after their kind." Bone points out that the most favorable temperature range for aromatic formations from such residues (500-800 deg.) coincides with that giving the best yields of benzene and its homologs and is well below that which is most favorable to the hydrogenation of the residues to methane. Between 500 and 800 deg. "ethylene is, by reason of its rapid production of CH residues (three free bonds) during its primary decomposition, eminently capable of generating aromatic nuclei, although to a less marked degree than in the case of acetylene. On the other hand, ethane, which primarily produces CH_2 residues (two free bonds) only, does not form aromatic nuclei so readily as does ethylene."

Another variation of the olefine theory is advocated by Whitaker and Crowell,¹³ who distilled coal in 5-lb. charges at different temperatures, and examined the liquid and gaseous products of carbonization. They suggest that the course of reactions in coal carbonization is as follows: "Solid coal \rightarrow high molecular weight paraffines \rightarrow low molecular weight paraffines; olefines \rightarrow acetylenes, naphthenes and polycyclic compounds \rightarrow benzene and its homologs \rightarrow higher homologs of benzene \rightarrow xylene \rightarrow toluene \rightarrow benzene, etc." Attention was directed to the apparent marked similarity between this series of decompositions and those postulated¹⁴

for oil cracking. A somewhat similar sequence of coal reactions has recently been advanced by Wigersma.¹⁵

THEORY OF THE DECOMPOSITION OF LOW-TEMPERATURE PHENOLS

The investigators whose work has been reviewed thus far have paid scant attention to the rôle of the phenols in secondary decompositions. In 1885 Schulze,¹⁶ on the occasion of his pioneer investigation of the naphthols of ordinary coal tar, stated that coal is essentially altered cellulose and that its primary decomposition products are the phenols. The phenols on further heating (1) eliminate water to synthesize high-boiling hydrocarbons; (2) are partly reduced to low-boiling hydrocarbons; (3) are decomposed to form gases; or (4) escape unchanged. These reactions were conceived as progressing simultaneously and in equilibrium with each other. So strong was the influence of Berthelot's theory at that time, however, that Schulze made his propositions simply to supplement rather than to displace the acetylene hypothesis.

Very recently Fischer and Schrader¹⁷ have also assigned to the phenols a part of major importance. They point out that low-temperature tars consist essentially of hydrocarbons similar to those of petroleum and of phenols, but contain no aromatic hydrocarbons. The benzene homologs in high-temperature coal tar must be formed from these phenols, they conclude, since the hydrocarbons can be converted into aromatics only to a slight extent. In support of this view experiments are cited on the decomposition of cresols and xylenols when passed through tinned tubes heated to 750 deg. in an atmosphere of hydrogen. The phenols were reduced to benzene homologs, and these in turn yielded some benzene. Thus, according to these authors' theories of the decomposition of low-temperature tar in coal carbonization, the aliphatic hydrocarbons are broken down into gases, while the hydroaromatic hydrocarbons are in part dehydrogenated and in part changed into gaseous hydrocarbons. A small portion of the phenols of the low-temperature tar remain unchanged, but most of them are reduced to such stable hydrocarbons as benzene, or take part in syntheses of naphthalene, anthracene and other aromatics.

THEORY OF DEHYDROGENATION AND DEALKYLATION

Pictet¹⁸ passed "vacuum tar" through a red-hot tube filled with pieces of coke, and obtained the typical products of high-temperature distillation. He concluded that the hydroaromatic hydrocarbons of vacuum tar underwent dehydrogenation and detachment of side-chains to yield aromatic hydrocarbons and the large quantity of hydrogen and methane homologs characteristic of high-temperature gases. This theory is supported by the known tendency of aromatic hydrides to lose a part of their hydrogen, by the occasional presence in ordinary tar of small quantities of hydroaromatic hydrocarbons, and by the fact that the cracking of naphthenic petrols yields a certain quantity of aromatic hydrocarbons. Since cyclohexane on cracking yields little benzene, and tends rather to break the ring with the formation of unsaturated aliphatic compounds, the cyclanes of coal, Pictet states, cannot have

¹¹H. Staudinger, R. Endle and J. Herold, *Ber.*, vol. 46, p. 2466 (1913).

¹²W. A. Bone, "Coal and Its Scientific Uses" (London, 1918), p. 143 et seq.

¹³W. A. Bone and H. F. Coward, *J. Chem. Soc.*, vol. 93, p. 1197 (1908).

¹⁴M. C. Whitaker and W. H. Crowell, *J. Ind. Eng. Chem.*, vol. 9, p. 261 (1917).

¹⁵Cf. publications by Rittman, Zanetti, Egloff, Leslie et al. in *J. Ind. Eng. Chem.* A very extensive review of the literature to 1916 on the pyrogenesis of hydrocarbons is given by E. L. Lomax, A. F. Dunstan and F. B. Thole, *J. Inst. Pet. Tech.*, vol. 3, p. 36 (1916); cf. W. Gluud, *Ges. Abhandl.*, vol. 2, p. 261 (1917).

¹⁶B. Wigersma, *Chem. Weekblad*, vol. 16, p. 1356 (1919).

¹⁷K. E. Schulze, *Lieb. Ann.*, vol. 227, p. 143 (1885).

¹⁸F. Fischer and H. Schrader, *Brennstoff Chem.*, vol. 1, pp. 4, 22 (1920); vol. 2, p. 37 (1921).

¹⁹A. Pictet, *Ann. chim. [9]*, vol. 10, p. 322 (1918).

contributed largely to the formation of benzene and its homologs.

It is the unsaturated cyclic hydrocarbons, he argues, which are present in much larger quantity, and which are hence the principal source of the benzene hydrocarbons of ordinary tar. Certain of the polycyclic hydrocarbons, such as fluorene, also owe their existence to simple dehydrogenation, since hexahydrofluorene was found in "vacuum tar." The origin of naphthalene and anthracene was regarded as still obscure, however, since no hydrogenated derivative of either of these was found in "vacuum tar" or in the benzene extract of coal.

LIMITATIONS OF EXPERIMENTAL METHODS IN CARBONIZATION STUDIES

It is desired to call attention at this point to certain conditions which complicate the study of carbonization reactions. Aside from such factors of prime importance as temperature and pressure, the course which these reactions take depends upon the relative concentrations of the reacting substances, and hence the nature of the coal carbonized, and upon the path of travel of the gases in the oven.¹⁰

Coals of oxygen content lower than normally used in commercial carbonization practice have been employed by some observers, who consequently lost sight of the effect which the higher phenol concentration would have in the formation of the typical aromatic hydrocarbons of ordinary tar. Carbonization reactions occur simultaneously, and represent complex equilibria, the individual factors of which are difficult to divorce from one another for separate investigation. When experiments on the decomposition of isolated hydrocarbons are quoted, translation of such results to commercial conditions is obviously open to question. The strongly reducing atmosphere of coke ovens and gas retorts is a factor that too often has been ignored in pyrogenetic assumptions. Thus it has been shown¹¹ that at 550 deg. benzene in an atmosphere of nitrogen readily loses hydrogen with the formation of diphenyl, but in the presence of an excess of hydrogen yields only traces of diphenyl. Toluene carried through coke in a stream of nitrogen at 750 deg. yields naphthalene, anthracene and a viscous black liquid. On the other hand, the substitution of hydrogen for nitrogen greatly accelerates the decomposition of the toluene, and produces large amounts of benzene and only a small quantity of solid condensate.

Attention is directed also to the difference in the results obtained in small-scale experiments and in commercial operation. For example, when 2-g. samples of coal are distilled¹² under a high vacuum in a platinum tube, there is obtained a maximum yield of tar at 750 deg., which is nearly four times that recovered at 450 deg. It is a well-known fact, on the other hand, that the yield of low-temperature tars on a commercial scale is about double that of ordinary high-temperature tars.

Again, Jones¹³ decomposed 0.1-g. samples of low-temperature tar in a glass tube filled with porous porcelain, and based much of his theory of carbonization reactions on the analysis of the gases obtained at different temperatures. If comparison is made of these results with

the gas analyses of Thau,¹⁴ who distilled coal in a commercial coke oven over the same range of temperatures, striking differences are at once manifest. The sudden increases in the evolution of hydrogen and of methane synchronizing with the disappearance of olefines and the appearance of aromatics noted by Jones is not apparent in the coke-oven analyses. As an example of the influence of retorting conditions, Thau found as a result of superheating the upper part of his coke oven that the hot surfaces of carbon were much more effective in causing decomposition than were the retort walls.

Interpretation of Carbonization Reactions in Terms of the Present Investigation

The low-temperature tar studied in the present investigation represents a stage of carbonization slightly more advanced than that which gave rise to the vacuum tars investigated by Pictet and by Jones and Wheeler. It was produced by the Carbocoal process¹⁵ in a commercial retort that afforded an opportunity for secondary reactions to take place to a limited extent. Thus the distillation vapors came into contact with the retort shell heated to about 600 deg., and yielded a product that is distinguished from these true low-temperature tars by (1) a slight decrease in the quantity of total phenols and a marked increase in the proportion of low-boiling phenols; (2) the appearance of a large percentage of tertiary nitrogen bases; and (3) a notable increase in the ratio of unsaturated to saturated hydrocarbons.

THE DECOMPOSITION OF LOW-TEMPERATURE PHENOLS DURING CARBONIZATION

A true low-temperature tar contains about ten times the quantity of phenols that appears ultimately in the high-temperature tar. Thus, a 30 per cent volatile coal produces a primary tar containing about one-quarter its weight of phenols, and yields in the coke oven about half this weight of tar containing less than 5 per cent of phenols. The low-temperature phenols consist principally of the higher homologs. High-temperature phenols, on the other hand, contain about two parts of cresols to one of phenol, together with a relatively insignificant proportion of higher-boiling tar-acids. It is thus apparent that while the phenolic components of the primary tar contribute very largely to the formation of secondary products, only a small part of them survive as phenols, and then chiefly as the first members of the series.

The low-temperature phenols, as would be expected, occupy a position intermediate between the extreme low-temperature type and the phenols of ordinary tar. The phenols obtained¹⁶ by steam distillation of a Lohberg gas coal at a temperature slightly lower than that in the case of the low-temperature phenols exceeded the latter in total quantity. The fraction of Lohberg phenols distilling below 230 deg. constituted only 7 per cent of the total weight, while the corresponding fraction of low-temperature phenols amounted to 57 per cent. It thus becomes evident that the first stage in the decomposition of the primary phenols is one which involves principally the elimination of the multiple short sidechains of the higher homologs. This reaction

¹⁰Cf. G. E. Foxwell, *J. Soc. Chem. Ind.*, vol. 40, pp. 193T, 220T (1921).

¹¹J. W. Cobb and S. F. Dufton, *Chem. Trade J.*, vol. 63, p. 197 (1918); *Gas World*, vol. 69, p. 127 (1918); *Gas. J.*, vol. 143, p. 482 (1918).

¹²M. J. Burgess and R. V. Wheeler, *J. Chem. Soc.*, vol. 97, p. 1917 (1910); vol. 99, p. 649 (1911); vol. 105, p. 131 (1914).

¹³O. Thau, *Brennstoff Chem.*, vol. 1, pp. 52, 66 (1920).

¹⁴Cf. J. J. Morgan and R. P. Soule (in the first division of this paper) for a description of the conditions of carbonization in the Carbocoal process.

¹⁵F. Fischer, *Brennstoff Chem.*, vol. 1, pp. 31, 47 (1920).

is probably accomplished by the replacement of the methyl or ethyl groups by hydrogen from the retort gases, with the formation of methane or ethane.

Again, when low-temperature phenols are passed through a tinned tube at 750 deg. in an atmosphere of hydrogen, there are obtained² low-boiling phenols and hydrocarbons, together with water. Higher temperatures, therefore, must eliminate the hydroxyl groups also, and the predominating reaction then becomes hydrogenation with the production of water. Moreover, cresol when passed over coke at 750 deg. in a stream of hydrogen yields benzene and toluene.²

The present investigation has shown that the low-temperature phenols contain about 10 per cent of naphthol derivatives. The hydrogenation of these with elimination of water is obviously one source of the naphthalene of high-temperature tar.

If the decomposition of the primary, monocyclic phenols were confined to such hydrogenation reactions, however, there would result in high-temperature tar a much higher yield of light oils and solvent naphtha than is actually the case. Experiment has shown² that monocyclic aromatic hydrocarbons also undergo the same reaction—e.g., xylene is converted into toluene, and toluene is converted into benzene, with the simultaneous formation of a small amount of solid condensate. Thus it was found² that the temperatures of maximum formation of xylene, toluene and benzene are respectively 600, 700 and 800 deg., and that the total quantity of light oil formed decreases steadily as the temperature of carbonization is increased above 500 deg. The limited quantity of benzene itself occurring in high-temperature tar, however, makes it necessary to conclude that in addition to the reactions enumerated, a portion of the benzene participates in pyrogenetic syntheses. It is possible also that some of the phenols sustain scission of the ring and are lost from the tar as gases, or, as Fischer and Schrader² suggest, condense to form polycyclic aromatic hydrocarbons. However this may be, it is nevertheless evident that the phenols are the chief source of the monocyclic aromatic hydrocarbons.

THE DECOMPOSITION OF THE NITROGEN BASES DURING CARBONIZATION

Since a considerable quantity of the nitrogen bases of low-temperature tars remains after distillation in the pitch, it is difficult to determine whether the total quantity is greater or less than in ordinary tar. It was found,² however, that the percentage of bases (3.42 per cent) boiling under 326 deg. in a mixture of coke-oven and gas-works tar was nearly double that (1.94 per cent) of the low-temperature tar. It is probable, therefore, that low-boiling bases are formed from high-boiling bases in a manner analogous to the decomposition of the high-boiling phenols.

Pictet's suggestion² that quinoline is formed from dihydroquinoline by simple dehydrogenation seems to be the most rational explanation of the primary decompositions of the low-temperature bases. Secondary bases of the type of dihydroquinoline are found in "vacuum tar," but tertiary bases are absent. The fact that 80 per cent of the low-temperature bases and almost all of the high-temperature bases are tertiary compounds supports this theory of dehydrogenation.

Experiments with the low-temperature bases demon-

strated the presence of unsaturated bases, the relative molecular weights² of which average 10 to 15 higher (Fig. 12) than the values of the corresponding high-temperature compounds. At higher temperatures (700 to 800 deg.), therefore, a process of combined dehydrogenation and dealkylation must take place to yield the ordinary bases such as quinoline and acridine. Moreover, the toluidines described by Pictet then yield the aniline of ordinary tar just as it has been shown that cresol yields phenol, and toluene yields benzene.

The low-temperature distillate was shown to contain no preponderating base, but to represent a series of

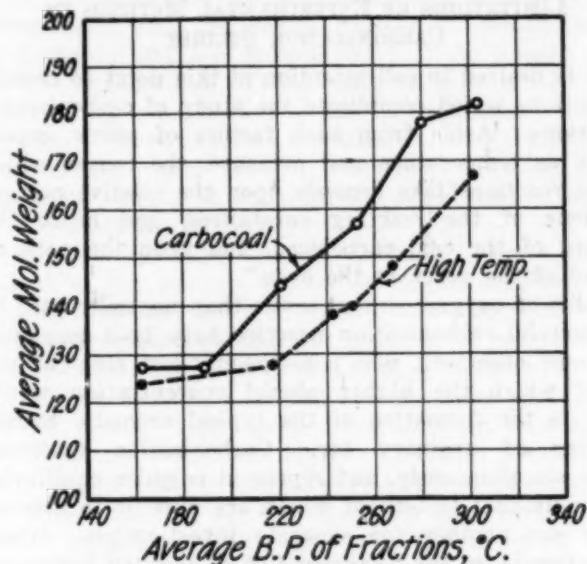


FIG. 12—AVERAGE MOLECULAR WEIGHTS OF BASES

compounds of increasing molecular weight. The distillation curves of Fig. 13 emphasize the preponderance of quinoline in the high-temperature bases, and indicate, if this theory is accepted, that the bulk of the middle-boiling bases of low-temperature tar are structural derivatives of quinoline, and yield this compound upon decomposition at the temperature of the coke oven. The physical constants obtained are consistent with this observation, and dehydroquinoline has been identified in "vacuum tar."

THE DECOMPOSITION OF THE HYDROCARBONS DURING CARBONIZATION

The ratio of saturated to unsaturated hydrocarbons is highest in the tars produced under high vacuum at the lowest temperatures. Thus the saturated hydrocarbons obtained by Jones and Wheeler were about equal in quantity to the non-saturated, while in low-temperature tar they formed only one-third of the distillate and a much smaller fraction of the entire tar. The obvious conclusion, therefore, is that the initial decomposition of the primary hydrocarbons is characterized by a partial dehydrogenation of the naphthenes to form hydroaromatics.

As mentioned above, Jones² was led to believe from his experience in the decomposition of cyclohexane, methylcyclohexane and the di- and tetrahydro-derivatives of naphthalene that the naphthenes cannot be regarded as the direct source of the high-temperature aromatic hydrocarbons through simple dehydrogena-

²Only relative values are given by the ordinary Beckmann cryoscopic method, since nitrogen bases are slightly associated in benzene solution.

²See first paper in this series.

tion and dealkylation. The large yields obtained of both the corresponding aromatic hydrocarbon and hydrogen were explained on the basis that "the most probable course of the reaction would be for the cyclohexane first to lose two atoms of hydrogen and form cyclohexene, which then decomposes in two ways, yielding benzene and butadiene." The principal reaction and the one contributing most largely to aromatic formation was held to be the condensation of such conjugated unsaturated nuclei as the butadiene represents. These nuclei are stated to result in the distillation of coal from the decomposition of the paraffines, the naphthenes and the unsaturated hydrocarbons of low-temperature tar.

Results in the low-temperature investigation, on the contrary, lead to the contention that while the elimination of hydrogen from the naphthenes of the primary low-temperature tar is the initial step in the decomposition reactions, the intermediate di- and tetra-hydroderivatives thus formed constitute a distinct and comparatively stable stage in the carbonization of coal. Consistent with his theory Jones considered these compounds to be partly olefinic. Pictet, on the other hand, identified them as unsaturated naphthenes, and advanced the rational hypothesis that the origin of the aromatics lay in a process of dehydrogenation of the aromatic hydrides and of detachment of sidechains from alkyl derivatives. The composition of the low-temperature hydrocarbons has been shown⁸⁵ to conform with this hypothesis of Pictet and to be consistent with all the experimental facts upon which Jones bases his interpretation.

THE ORIGIN OF NAPHTHALENE IN COAL TARS

The bulk of the unsaturated hydrocarbons of low-temperature tars are polycyclic. While some of the naphthalene of ordinary tar results from the hydro-

carbons is indicated in low-temperature tar by the physical and chemical properties. For example, the average molecular weights⁸⁶ of the middle-boiling fractions (Fig. 14) are notably higher than that of naphthalene. Fig. 15 shows that the secondary reactions giving rise to high-temperature tar decompose these bicyclic hydrocarbons to the single stable naph-

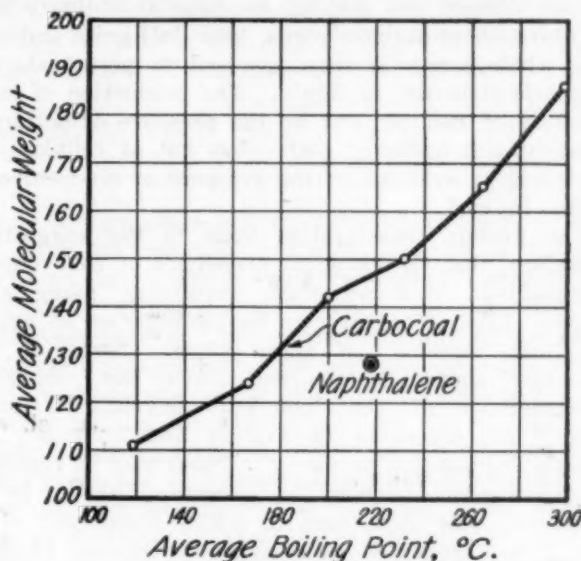


FIG. 14—MOLECULAR WEIGHTS OF NON-SATURATED HYDROCARBONS

thalene nucleus, the presence of which in large quantity is one of the outstanding features of ordinary tar. The analogy between naphthalene and quinoline in chemical structure makes more striking the similarity between the carbonization reactions of the hydrocarbons and nitrogen bases.

A THEORY OF THE CYCLIC STRUCTURE OF COAL

Probably the most remarkable general characteristic of low-temperature tars is the fact that they are almost entirely cyclic in nature. So far as the various compounds have been identified, moreover, these cycles have shown themselves to be six-membered rings or combinations of six-membered rings. This structural characteristic apparently persists in the tar as the temperature of distillation of the coal is increased.

It seems reasonable, therefore, in view of the great stability of the six-membered ring, to ask if this structure is not characteristic also of the coal substance itself. Such a conception is contrary, of course, to the widely accepted cellulose-furane theory.⁸⁷ Fischer and Schrader⁸⁸ have recently stated that the plant cellulose is destroyed by bacterial activity in the early stages of peat formation, and pointed out, moreover, that while cellulose yields on decomposition almost exclusively phenol itself, low-temperature tars contain chiefly the higher homologs of phenol. In the absence of cellulose the lignin must hence be the source of the phenols of coal tar.

The cyclic structure of lignin has been advocated by these authors, who assign to it an aromatic configura-

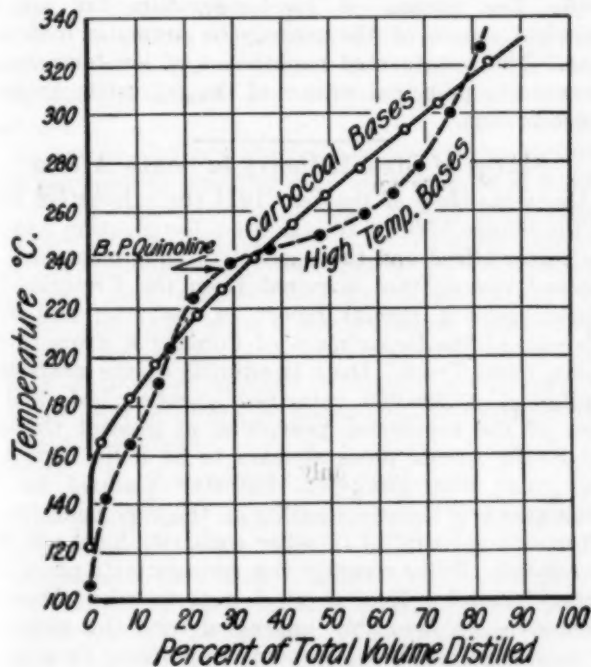


FIG. 13—DISTILLATION OF BASES

genation of naphthols, it is believed that the naphthalene and other polynuclear aromatic hydrocarbons owe their origin chiefly to the decomposition of these polycyclic unsaturated compounds. The presence of a series of homologs of hydrogenated and alkylated bicyclic hydro-

⁸⁵Determined in benzene solution by the Beckmann cryoscopic method.

⁸⁶D. T. Jones and R. V. Wheeler, *J. Chem. Soc.*, vol. 105, pp. 140, 2562 (1914); vol. 107, p. 1318 (1915); vol. 109, p. 707 (1916); cf. also "Monograph on the Constitution of Coal," by M. C. Stopes and R. V. Wheeler (London, Dept. Sci. and Ind. research, H. M. Stationery Off.) for an exhaustive review of the knowledge on this subject in 1918.

⁸⁷F. Fischer and H. Schrader, *Brennstoff Chem.*, vol. 2, p. 37 (1921); cf. Klever, Jonas and Keppeler, *ibid.*, vol. 2, p. 213 (1921), and Fischer and Schrader, *ibid.*, vol. 2, p. 237 (1921).

tion with acetyl and methoxyl groups. During coal formation the methoxyl content must eventually decrease through saponification, reduction or replacement by hydroxyl groups. In any case there results a phenol, which is considered identical with humic acid. Oxidation or polymerization of humic acid forms the alkali-insoluble humin. Further splitting off of water, carbon dioxide and perhaps methane at ordinary temperature, these authors argue, leads to lignite and coal. The whole series is thus assumed to perpetuate the aromatic structure of lignin. The production of large amounts of mellitic acid by the pressure oxidation of charcoal and ordinary coals (but not of cellulose) is contributory evidence of the presence of six-membered cycles in coal.

The present investigation leads to the suggestion, therefore, that the chemical properties of coal may be represented by a structure containing many such cycles. This structure may be pictured as an aggregate of "mosaics" of these rings. Some of the "mosaics" contain oxygen, and display the insolubility characteristic of the "cellulosic degradation products,"¹⁰ or, according to Fischer and Schrader, the "lignin degradation products." These may be regarded as polymerized phenols, as suggested above, or as multi-molecular structures in which component rings are joined together by oxygen-containing bridges. Heating results in the breaking of these bridges with the formation of high-boiling phenols, the sidechains of which are remnants of other broken linkages.

Similarly, other "mosaics" may be pictured to represent the same typical rings held together by bridges of paraffine hydrocarbons, the breaking or detachment

SUMMARY OF THE MECHANISM OF COAL CARBONIZATION

(1) The decomposition of the coal substance to ordinary high-temperature tar when subjected to the action of heat is a process of progressive, step-by-step decomposition, in which pyrogenetic syntheses play only a secondary part.

(2) Six-membered rings and combinations thereof characterize the entire series of decomposition products from coal to high-temperature tar. The decompositions during carbonization are essentially reactions effecting the elimination of sidechains.

(3) The average molecular weights of the liquid intermediate products constantly decrease as the temperature of carbonization rises. This decrease is marked by the evolution of hydrogen, methane and ethane.

(4) The initial decomposition of the low-temperature tar first formed is brought about by (a) loss of hydrogen from a portion of the naphthenes with a resultant increase in the proportion of unsaturated hydrocarbons; (b) loss of sidechains from the phenols by hydrogenation with the resultant formation of lower-boiling phenols; and (c) loss of hydrogen from the nitrogen bases to form a large proportion of tertiary compounds. (This stage is represented by Carbocoal tar.)

(5) Final decompositions are at a maximum between 700 and 800 deg., and are marked by (a) dehydrogenation and dealkylation of the hydroaromatic unsaturated hydrocarbons and nitrogen bases to form aromatics, with the elimination of hydrogen, methane and other simple gases; (b) hydrogenation of the phenols to aromatic hydrocarbons and of these aromatic hydrocarbons to lower-boiling aromatics, with the formation of methane, ethane and water; and (c) secondary pyrogenetic syntheses of higher aromatics from simple compounds.

(6) The phenols of low-temperature tar are the principal source of the monocyclic aromatic hydrocarbons. The unsaturated naphthenes of low-temperature tar are the principal source of the polycyclic aromatic hydrocarbons.

Status of Steel Industry in South Africa

Up to the close of the year 1921 the exhaustive plans of the South African Iron & Steel Corporation had not yet materialized and the productive equipment had not reached beyond that acquired from the Pretoria Iron Works, says a special report to the Iron and Steel Division of the Department of Commerce, from Consul Pissar, Cape Town. Over two-thirds of the authorized capital of £1,500,000 remained unsubscribed, and in view of the depression prevailing at present throughout South Africa there appears to be little hope that the great iron and steel industry planned by the promoters will become a reality in the very near future. Efforts to get capital in other countries have not been successful. Quite recently the corporation's properties were visited by English steel experts who expressed themselves as favorably impressed with the prospects of this venture. Until economic conditions throughout the world become stabilized and the corporation can obtain the necessary capital and produce steel on a competitive basis, no material results can be expected.

The operations of all the steel mills in South Africa resulted in a production of 21,988 tons of steel goods in 1921. The industry gave employment to an average number of 285 white men and 866 colored laborers.

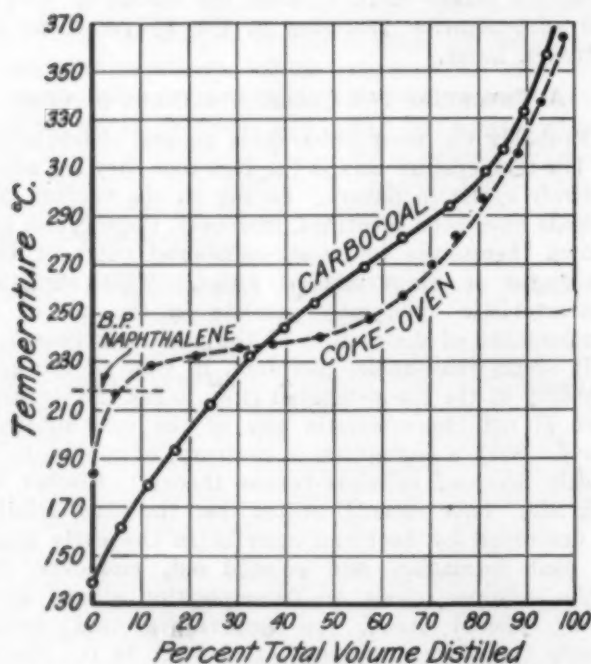


FIG. 15—DISTILLATION OF HYDROCARBONS

of which are responsible for the presence of straight-chain hydrocarbons in low-temperature tars," or even in seams of the coal deposits themselves. These structures are more soluble, and have been called the "resinous constituents."¹¹ Nitrogen and sulphur compounds may be regarded as appearing in strictly analogous configurations.

¹¹Cf. the "bound molecules" of Jones and Wheeler (Ref. 59).

Application of Electrical Precipitation to the Wood-Distillation Process*

Tests on Experimental Wood-Distillation Retort Indicate the Possibility of Precipitating the Tar From the Hot Vapors by Means of a Cottrell Precipitator, Thus Reducing the Amount of Soluble Tar in the Pyroligneous Acid to a Point Where Direct Neutralization Is Feasible

By L. F. HAWLEY† AND H. M. PIER‡

IN THE commercial distillation of hardwood for the preparation of wood alcohol and acetate of lime the first operation after the distillation of the wood and the condensation of the liquid products consists in the distillation of the pyroligneous acid for the purpose of separating the tar which is dissolved in the acid. The distilled acid is then neutralized with lime, distilled to remove the alcohol, and evaporated in order to obtain the acetate of lime. If the pyroligneous acid were not distilled before neutralizing with lime, much of the tar in solution in the crude acid would stay in solution after neutralization and, therefore, contaminate the acetate of lime. The so-called dissolved tar which is removed from the pyroligneous acid by distilling off the acid is not a tar like the settled tar consisting of oils and pitch, but is really a pitch containing very small proportions of oil, soluble in the pyroligneous acid on account of the presence of acetic acid and methanol.

PREVENTING FORMATION OF SOLUBLE TAR

Since this contaminating pitch or tar is non-volatile, it must be carried over from the retort to the condenser in the form of a fog or mist consisting of very fine drops of liquid pitch. Attempts have been made to prevent this pitch from reaching the condenser by interposing baffle plates and other mechanical devices between the retort and the condenser, but without success.

Since the Cottrell precipitator is able to precipitate fine particles of liquid or solid when carried in a stream of gas or vapor, it was thought that it could stop the non-volatile portion of the wood distillate before it reaches the condenser. In order to try out this idea a few tests were made at the Forest Products Laboratory at Madison, Wis., with a small Cottrell precipitator by treating the gases from the experimental retort, in which 50 to 60 lb. of wood is distilled per charge. The Cottrell precipitator was connected between this retort and the condenser.

DESCRIPTION OF APPARATUS

The precipitator, as shown in Fig. 1, consisted of a three-pipe unit contained in a shell made of 6-in. wrought-iron pipe and fittings. The collecting electrodes consisted of three pipes of light sheet steel, 2 in. in diameter and 24 in. long. The discharge electrodes, which hung through the central axis of the pipes, consisted of small chains, weighted at the bottom to keep them taut. The chains were later replaced by roughened 1/4-in. rods. The discharge electrodes were hung

from a plate above the tubes and were spaced in proper position by means of a spacer-frame below the tubes. The top plate was carried on a pipe which extended through the insulator at the top of the precipitator. As indicated in Fig. 1, this insulator served as the support for the discharge electrodes as well as an inlet bushing, and was the only electrical insulation used.

The path of the gases can be readily seen in Fig. 1. The raw gases from the retort entered the precipitator at a point just under the header plate, passed downward around the outside of the tubes, in order to insure equal distribution, and finally up through the tubes, where the tar was removed by the electrical action.¹ The cleaned gas passed from the precipitator to the condenser through a 2-in. pipe as shown.

Since the precipitator was fairly large in comparison with the size of the retort and since it, therefore, afforded a large surface for heat radiation and condensation, it was decided to prevent this condensation by lagging the precipitator and to hold the temperature at the desired point by means of external heat.

The electrical equipment used for providing the unidirectional high-voltage current for use in the precipitator is shown in Fig. 2, and consisted of a synchronous induction motor which drove a mechanical rectifier, a special high-voltage transformer and auxiliary apparatus such as switches, meters, rheostats, etc. The power supply was 110 volt, 60-cycle alternating current. This was stepped up to 220 volts by means of an auto-transformer; the special high-voltage transformer raised the 220-volt current to the voltage desired (10,000 to 15,000 volts). This high-voltage current was then rectified to unidirectional current by means of the mechanical rectifier, which is practically a synchronously driven switch. The electrical connections between the various items of the equipment are shown in Fig. 3.

DEFECTS IN EXPERIMENTAL APPARATUS

As is the case with any small-scale apparatus, there were a few inherent defects in the design of this experimental precipitator, all of which are readily eliminated in larger or commercial installations. The discharge electrodes first used in these experiments were chains hung from the top spacer-plate. As soon as the high-voltage power was applied to the precipitator, these chains showed a tendency to swing due to the electrical stresses set up and the electrical windage. These swinging chains, weighted at the bottom, acted as pendulums, and it was impossible to stop the swinging except by ceasing operations. As soon as the chains

*Presented before the American Chemical Society at Rochester, April 27, 1921.

†Chemist in Forest Products, Forest Products Laboratory, U. S. Forest Service, Madison, Wis.

‡Research Corporation, Chicago, Ill.

¹The theory of electrical precipitation has been discussed so frequently in various publications that it was not deemed necessary to repeat it in this article.

started to swing, the proper gap distance between them and the pipes was not maintained and serious disruptive arcing took place, thereby destroying the efficiency of precipitation. In order to eliminate this trouble, the chains were replaced with discharge electrodes made of $\frac{1}{8}$ -in. rods roughened to give points for electrical discharge. This eliminated the swinging, but it also meant the use of an electrode less satisfactory from the viewpoint of electrical discharge. In a commercial installation consisting of a greater number of pipes of larger size, it is a simple matter to install a rigid electrode system and still have the benefit of the superior discharge from chains.

Another difficulty encountered with this test precipitator was electrical insulation. As can be seen from the sketch of the precipitator, Fig. 1, the insulation was more or less in the path of the gas flow, with the result that any small amount of tar, oil or other mate-

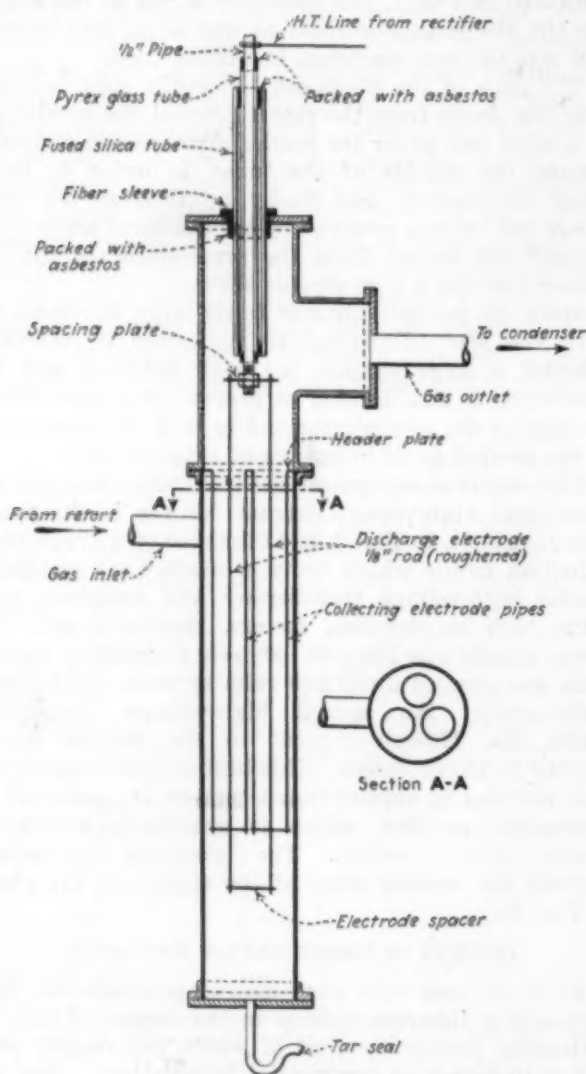


FIG. 1—TEST PRECIPITATOR FOR TAR

rial that passed through the pipes had a tendency to adhere to the rough surface of the fused silica and thus create a path for the leakage of electrical power. Several runs were characterized by insulation trouble, with a resultant loss of efficiency. In larger precipitators this is readily eliminated by installing all insulation in separate compartments entirely removed from the gas stream, thereby keeping the insulators clean at all times.

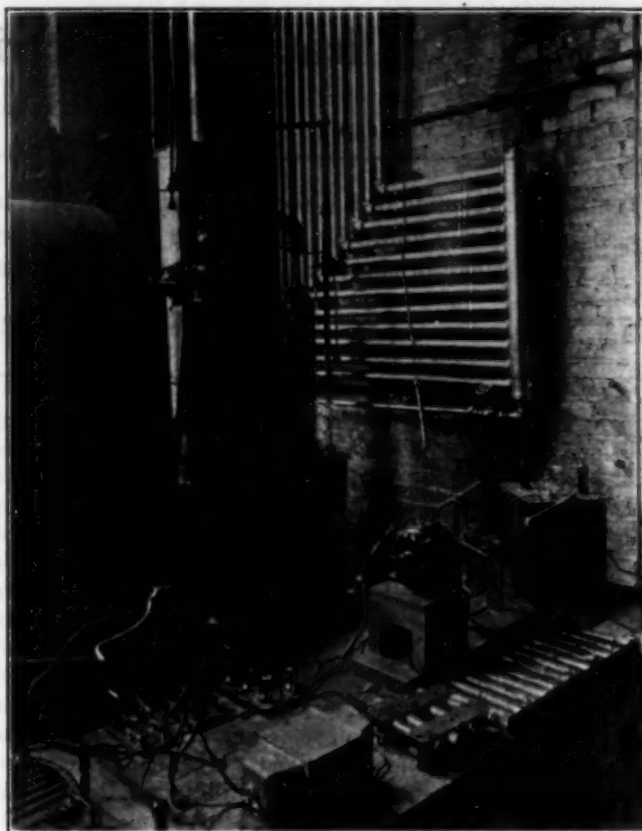


FIG. 2—COTTRELL PRECIPITATOR IN USE WITH WOOD-DISTILLATION RETORT

TAR PRECIPITATED AS LIQUID UNDER PROPER TEMPERATURE CONDITIONS

During the first two runs the precipitator was heated to give the vapors at the outlet from the precipitator a temperature of about 160 deg. C. After the precipitator had been in operation under these conditions for a short time and before the runs were half completed serious arcing occurred in the precipitator, and the current had to be turned off during the rest of the distillation. On examining the inside of the precipitator it was found that a deposit of hard pitch had built up from the inside surface of the tubes toward the chains, and in one case this deposit reached all the way across between the tube and the chain, making a dead short-circuit. This material was very brittle and on being heated to high temperatures coked without any tendency to melt.

This indicated that the material being precipitated consisted of a pitch so very hard that at the temperature of the precipitation it did not flow readily and finally built up a solid deposit. This was probably due to the fact that at the temperature of the precipitation all the oils, even the higher boiling oils, were in the form of a pure vapor and, therefore, passed through the precipitator. Only the particles of hard pitch were in liquid form and this product was, therefore, the only material precipitated. In the next runs the temperature of the precipitator was kept near 100 deg. C. and at times a small amount of water may have been condensed in the precipitator. Under these conditions the deposit was a liquid tar containing pitch, oils, and perhaps a small amount of water corresponding to settled plus dissolved tar. This tar was not very thick even at ordinary temperature and at the temperature inside the precipitator it was sufficiently liquid so that it drained from the tubes without any difficulty and there was no

short-circuiting at any time throughout the run. This precipitated tar flowed from the trap in the bottom of the precipitator continuously throughout the latter part of the runs.

CONDENSATE LOW IN SOLUBLE TAR

The distillate which passed through the precipitator and was condensed and collected was clear and with only a little color during the first part of the run, but during the last part the color became darker and a small amount of dark-colored oil separated from the pyroligneous acid. This pyroligneous acid, however, was not so dark as that ordinarily obtained and on distillation it was found to contain only 3.3 per cent of soluble tar, whereas the ordinary pyroligneous acid obtained from the same retort contains from 12 to 15 per cent soluble tar.² An acetate of lime made by neutralizing this pyroligneous acid just as it came from the condenser contained 77.8 per cent calcium acetate whereas laboratory-made acetate of lime from redistilled pyroligneous acid contained 82.5 per cent calcium acetate.

Although a large proportion of the pitch had been stopped in the precipitator, yet a sufficient quantity came through to contaminate the acetate seriously. Another run was made in which it was attempted to keep the voltage higher, but this could not be done without serious arcing. It was finally decided to make another

which escaped precipitation or whether it is due to materials which came through the precipitator as a pure vapor but which polymerized to a non-volatile pitch either on neutralizing with lime or on distilling during the soluble tar determination. This assumption that the contaminating material came through the precipitator at least in part as true vapor is very plausible, since Klason³ has shown that there is a continuous decomposition of the primary tar from the distillation of wood into a secondary tar consisting of pitch and heavy oils. In the small retort used in these experiments the distance from any decomposing particle of wood to the precipitator is very short and the transformation of the primary tar into secondary tar may not have been complete before the precipitating chamber was reached. If this was the case, there might be a formation of non-volatile pitch in the vapors after they had passed through the precipitating chamber. Therefore, a non-volatile material would be found in the distillate through no fault of the precipitating apparatus.

COMMERCIAL UNITS SHOULD GIVE BETTER RESULTS

There is more opportunity in a commercial-sized retort for the decomposition of primary tar to secondary tar before the precipitator is reached, in which case the tar would be removed from the gas in passing through the precipitator. On the other hand, if this tar came through the precipitator as a fog, it was because the velocity of the gas passing through the pipes was too great to permit of complete precipitation. The use of a greater number of pipes would overcome this, as the efficiency of precipitation varies inversely as the velocity of the gas through the precipitator.

CONCLUSIONS

Although the small-scale experiments have not removed the last traces of pitch and although a satisfactory acetate of lime could not be made from the directly neutralized pyroligneous acid, yet the experiments have shown that the general idea of precipitating tar from hot vapor is a possibility. Furthermore, there is still no reason to believe that in commercial-scale apparatus the formation of secondary tar may not be more complete before the vapors leave the retort and that a purer pyroligneous acid might not, therefore, be obtained by this method.

Switzerland's Aluminum Industry

Before and even during the war, the production policy of the Swiss aluminum industry was directed toward supplying the German aluminum-working industries with raw aluminum. The depreciation of the mark and the increase in German aluminum production during the war, however, induced the German aluminum-working industries to abandon the Swiss metal. While in 1913 5,644,700 kg. of aluminum and in 1920 3,542,400 kg. were exported to Germany, these exports dropped in 1921 to 1,646,100 kg. This compelled the Swiss aluminum industry to look for new markets, which were found in 1921 in the United States and Japan. Thus in 1921, 3,420,600 kg. of aluminum, to the value of 8,523,000 francs, went to the United States, and 894,100 kg., valued at 2,075,000 francs, to Japan. Besides this, Switzerland's aluminum industry, concentrated in the Aluminium Industry Society of Neuhausen, is paying more attention to the aluminum-working industries of Switzerland.

³J. prakt. Chem. (2), vol. 90 p. 413 (1914).

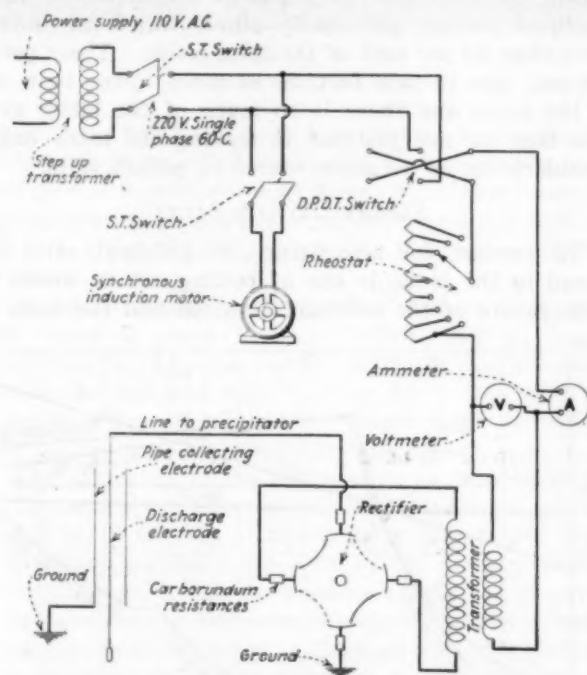


FIG. 3—TYPICAL PRECIPITATOR CIRCUIT

trial in which the distillation would be run at slower speed and this was done with a distillation taking 5½ hours instead of the usual time of 3½ hours. Even under these conditions, however, no better results were obtained.

SOME TAR MAY PASS THROUGH PRECIPITATOR AS TRUE VAPOR

It is impossible to tell whether the soluble tar found in the pyroligneous acid which has come through the precipitator is due to a small proportion of tar fog

²Although these figures might give the impression that the precipitator was only $15 - 3.3 \div 15 = 78$ per cent efficient in removing tar from the vapors, it must be noted that not only 78 per cent of the soluble tar but all the settled tar was removed. This is an efficiency of about 90 per cent.

Evaporation of Potash Brines at Deep Springs Valley, California

Some Interesting Modifications in the Methods of Recovering Potash From Natural Brines
Have Been Introduced at the Experimental Plant of the Inyo Chemical Co.—
Checking Foaming in Evaporation—Removal of Borax in Centrifuge

BY LEROY A. PALMER

EXPERIMENTAL and research work in the treatment of potash brines at a pilot plant in Deep Springs Valley, Inyo County, California, has developed what appears to be a very practical process for the economical extraction of the valuable portions of the great saline deposits found at different localities in the American desert.

The brine is obtained from a "salt marsh" or "dry lake," as the deposits are frequently called, of an area of about $1\frac{1}{2}$ square miles. It is a typical saline deposit formed by the dessication of a Quarternary lake having no outlet, in which waters only moderately alkaline became, by continued addition of solid matter and evaporation of the water, a highly concentrated mass of alkaline minerals. The deposit is covered by a glistening snow white crust, the principal constituent of which is sodium chloride.

NATURE OF THE DEPOSIT

The strength of the solution increases toward the center of the deposit, which is marked by a "crystal body" in which supersaturation has occurred so that various sodium and potassium minerals have crystallized out in many interesting and unusual forms. The interstices of these crystals are filled with the brine from which they were thrown down, while below and on all sides of the crystal bed is a deposit of thin watery mud, in which the minerals exist, but, due to the presence of the mud, in less proportion than in the brine.

It is not the purpose of this paper to discuss the origin of this deposit. The reader who is interested in that phase may refer to Hoyt S. Gale's "Salines in the Owens, Searles and Panamint Basins, Southeastern California" and in the portion referring to Searles Lake will find a description of conditions generally similar to those at Deep Springs Lake.

While this similarity of origin exists, the Deep Springs brines and muds have been found to be somewhat richer than those of Searles Lake. Gale reports six analyses of anhydrous salts from Searles Lake by Walton Van Winkle of the Geological Survey which show an average of 6.28 per cent K and one by W. H. Ross of the Bureau of Soils which shows 6.06 per cent K, equal to 7.48 per cent and 7.28 per cent K_2O respectively. The hypothetical combinations in the anhydrous residue of the Searles Lake brine, based on an average of these seven analyses reported by Gale, are given in column A of Table I.

¹U. S. Geological Survey Bull. 580. See also "Potash From Searles Lake," by Alfred D. Ropp, Jr., CHEM. & MET. ENG., vol. 19, No. 6, pp. 425-38, Sept. 26, 1918, and "Salts Refining at Owens and Searles Lake," by L. W. Chapman, CHEM. & MET. ENG., vol. 24, No. 16, April 20, 1921.

²U. S. Geological Survey Bull. 580, pp. 276-277.

Columns B and C are analyses of two samples of brine taken from one of the test wells put down in the crystal body at Deep Springs Valley. Both samples are from the same hole, but C is lower than B due to the fact that surface water had got into the hole after B was taken and had diluted the brine. It is given for the purpose of certain comparisons to be made later. B₁ gives the hypothetical combination of the anhydrous residue of B. The potash content of these on a basis of percentage of the total solids is 25.6 per cent KCl in B and 21.5 per cent in C.

The muds, too, contain an appreciable amount of potash, but they also carry a large proportion of water-insoluble matter, principally silica, which amounts to more than 80 per cent of the total solids. Their potash content, due to this fact, is so much lower than that of the brine and there is so much of the latter available that we are justified in leaving the muds out of consideration as a future source of potash salts.

SEPARATING THE SALTS

The process for separating the different salts contained in the brine is one of boiling out in which the temperature of the solution is varied and the salts are

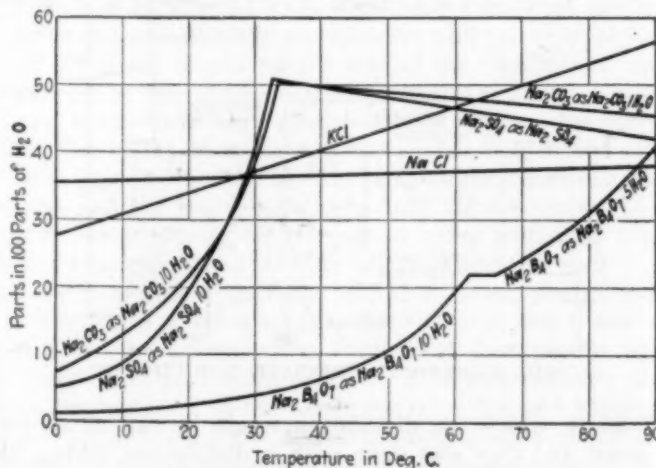


FIG. 1—SOLUBILITY CURVES FOR ALKALI SALTS FOUND IN POTASH BRINES

thrown down in the order of their solubilities. Fig. 1 shows the solubility curves of the commoner alkali salts reckoned in parts of the salt in one hundred parts of water and based on experiments with the individual salts. No curves showing the solubilities of the various salts in combination have been determined, as the solubility of each would vary with every change in the proportion of the salts to each other.

The principle involved in the process is simple and

has been applied, in one form or another, in many attempts to make a commercial product from natural brines of this character. But, as is frequently the case, efforts to develop the process on a practical basis have been beset by many obstacles, most of them unforeseen and of an unexpected nature.

The work at the Inyo Chemical Co.'s plant has been carried on by the Industrial Research Co. of San Francisco, under the direction of its president, Clinton E. Dolbear, and it is claimed that the process developed has overcome the usual obstacles and simplified the entire cycle of operations.

The experimental plant, shown in Fig. 2, has been built on the shore of the lake, into which a light pier

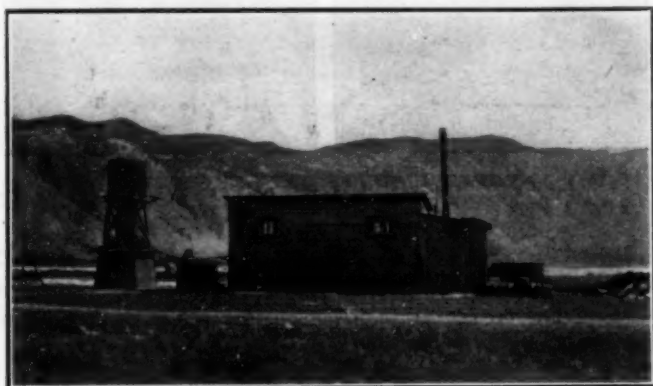


FIG. 2—EXPERIMENTAL PLANT ON SHORE OF DEEP SPRINGS LAKE

or runway has been built for a distance of about half a mile, so as to reach the crystal body. At the end of the pier is a gasoline engine and centrifugal pump, by which the brine is pumped to four concrete vats, each 20 x 20 x 1 ft. (3,000 gal.) on the shore adjacent to the plant.

In actual practice refrigeration will be used to chill the brine in these vats. Artificial chilling was not necessary in the experimental work, as this was carried on in the fall and winter when the nights were sufficiently cool at this altitude—about 5,000 ft.—to give the desired temperature by natural means.

The first step in the segregation process takes place in these cooling vats, in which the temperature is reduced to 10 deg. C., at which point the greater part of the sodium sulphate and some of the sodium carbonate crystallize out. The experiments show that an average of 31 per cent of the salts is removed at this stage and that the crystals take with them an equal proportion of the water of the brine as water of crystallization and as entrained moisture.

The effect of refrigeration is shown in column D of

Table I, which is an analysis of sample C after it had been subjected to the chilling process described. The same on a moisture-free basis is given in column D₁.

The liquor remaining after the partial crystallization resulting from the chilling is drained to a sump in the mill and there mixed with the mother liquor from previous treatments in the approximate proportion of two parts of refrigerated brine to one mother liquor. A centrifugal pump raises the mixture from the sump through a 2-in. pipe line to a 1,000-gal. galvanized-iron tank on the second floor, preparatory to the second stage of the process.

A typical analysis of the mixture of refrigerated brine and mother liquor is shown in column E.

EVAPORATION

Evaporation is effected in a 30-in. single-effect Swenson "steam basket" type evaporator shown in elevation in Fig. 3. The evaporator is filled by gravity from the 1,000-gal. tank through the 2-in. liquor inlet shown at the left. In the first filling the liquor goes direct to the evaporator, but when this is filled and evaporation is under way the liquor is bypassed to a small tank in which is a float valve connected to a half-inch feed pipe. The flow to the evaporator is regulated by this valve so that a uniform water level is maintained about 3 in. above the top of the steam basket and a fixed volume of brine is kept in the evaporator. The float valve thus regulates the feed so that the inflow and evaporation balance.

The essential feature of this type of evaporator is the steam basket in the lower half of the cylindrical portion. This steam basket is cylindrical in shape, 20 in. in diameter, 30 in. in length, with thirty tubes, each 2 x 30 in., set in it longitudinally. Live steam is admitted through the 2½-in. steam line shown on the left, passes through the pipe in the upper part of the cylinder and into the top of the basket, the purpose of which is merely to expose a large heating surface to the brine which surrounds the basket and fills the tubes. One can get a good mental picture of the process by comparing it with the well-known water-tube boiler, the brine taking the place of the boiler water and the steam the place of the furnace gases. With the large radiating surface presented by the steam basket the brine is quickly brought to boiling, which, at this altitude, is from 211 to 217 deg. F., according to the density.

CHECKING FOAMING

Here occurs one of the bugaboos of evaporation as applied to these natural brines. Due, supposedly, to the presence of organic matter, the liquor foams violently when the temperature is raised to boiling—

TABLE I—ANALYSIS OF NATURAL POTASH BRINES AND RESIDUES OBTAINED THEREFROM (RESULTS EXPRESSED IN PER CENT)

	A	B	B ₁	C	D	D ₁	E	F	G	H	H ₁	I	J
	Hypothetical Com- position of Sealed Lake Residue*	Brine From Deep Springs Valley	Hypothetical Com- binations in Resi- due From B	Brine From Deep Springs Valley	Brine C After Refrigeration	Hypothetical Com- binations in Resi- due From D	Refrigerated Brine and Mother Liquor Mixture	Wasted Liquor During Run	Wasted Liquor at End of Run	Composition of En- riched Liquor	Composition of An- hydrous Residue From H	Mother Liquor for Re-use	Average of Nine Lots of Final Product
Specific gravity.....	1.3065	1.2896	1.2496	32.91	9.53	5.58	8.08	22.33	51.10	8.94	96.91		
Potassium chloride (KCl).....	12.07	8.82	25.57	7.27	9.82	35.08	10.27	52.07	46.78	8.99	20.78	8.42	1.63
Sodium chloride (NaCl).....	51.61	4.82	13.97	11.53	11.19	7.29	2.07	15.56	20.36	1.35	3.12	2.60	0.14
Sodium sulphate (Na ₂ SO ₄).....	19.22	14.59	42.27	8.88	1.81	21.20	7.76	11.66	21.20	7.32	16.92	11.41	0.26
Sodium carbonate (Na ₂ CO ₃).....	12.79	6.27	18.17	5.36	5.94	3.50	1.76	3.16	4.06	3.50	8.08	3.11	0.13
Sodium borate (Na ₂ B ₄ O ₇).....	3.23	.....	.....	0.70	1.09	.....	.....	.....	.....	.....	.....	.....	.....
Sodium arsenate (Na ₂ AsO ₄).....	0.17	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

* Average based on seven analyses reported by H. S. Gale.

so violently, in fact, that the capacity of the evaporator is greatly reduced and a period of 38 hours was required in this case to concentrate the brine to saturation with KCl. Obviously a cycle of that length was expensive and some means was necessary to reduce the time required.

This foaming during evaporation is a trouble that has been encountered in all attempts to boil these natural brines, and a great deal of experimental work has been carried on at different plants in efforts to devise means to overcome it. Various processes, most of them only partly successful, have been tried. These have included the use of crude oil, gasoline, animal fats and oils, passing all brine through decolorizing charcoal, etc. Some of these were only partly successful, while others were successful in the matter of checking the foaming, but were too expensive to be of any value from a practical standpoint.

The introduction of slop distillate, not a new expedient, was tried at this plant by feeding it in slowly

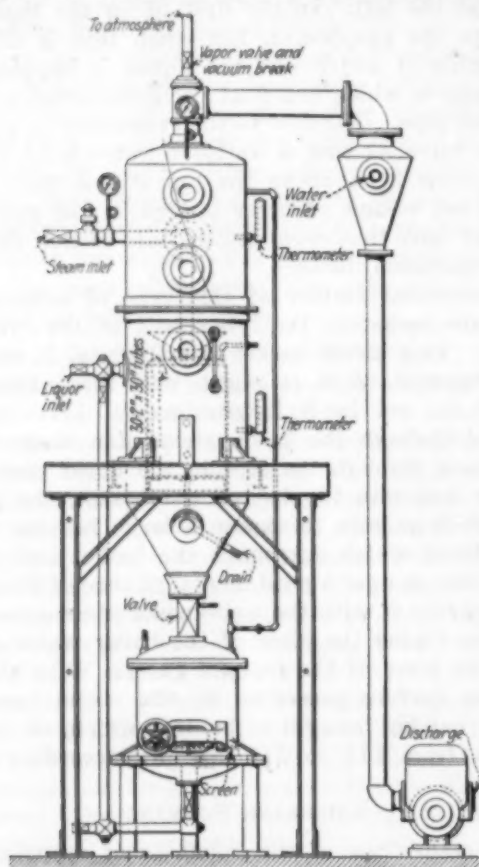


FIG. 3—ELEVATION OF SINGLE-EFFECT PATENTED BASKET TYPE EVAPORATOR

from a small reservoir. By increasing the surface tension of the liquor in the evaporator the introduction of the distillate retarded the foaming and cut the time required for saturation to 14 hours.

This was still much longer than was desired, and another method was tried. Thin strips of sheet lead were suspended in the brine with one end of each strip in contact with the steel of the evaporator. This set up a galvanic current between the lead and the steel which liberated oxy-chlorides from the brine and these exerted an oxidizing action on the organic compounds that were causing the trouble, the reaction serving to retard the foaming. The use of the lead strips cut the time required for saturation to 14 hours, the same as

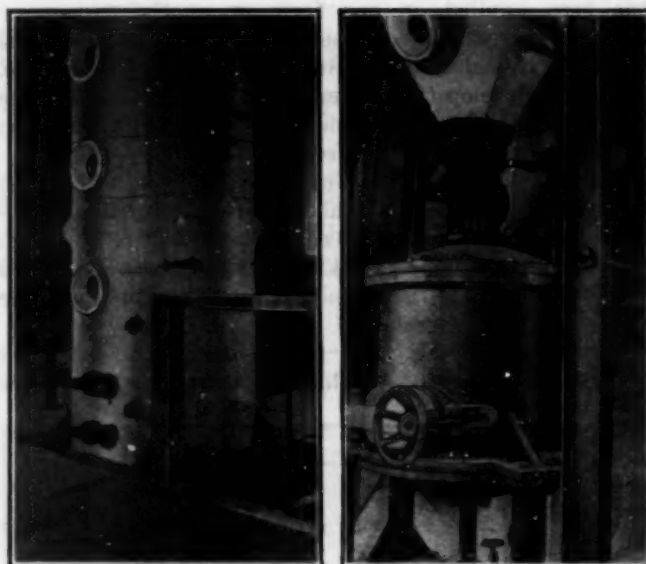


FIG. 4—VIEWS OF UPPER (AT LEFT) AND LOWER PORTIONS OF EVAPORATOR

with the slop distillate. The next step was a combination of the two and this met with success, complete salting out so far as possible at this stage taking place in 4 hours.

SALTING OUT

Reference to the solubility curves shows that above a temperature of approximately 65 deg. C. potassium chloride has a greater solubility than any of the other salts under consideration. With the increase in temperature in the evaporator sodium chloride is crystallized out, and almost immediately thereafter all of the remaining sulphate except about 3 per cent is thrown down, leaving a concentrated liquor in which KCl is the principal constituent.

During evaporation the brine is tested by drawing off about 50 c.c., permitting it to stand 30 seconds and then filtering it through a Gooch crucible. The dried salts from the filter paper are redissolved and tested with sodium cobalt nitrite, and if the reaction shows a satisfactory potash content, the evaporator is emptied.

The chloride, sulphate and carbonate crystals settle through the conical part of the evaporator into the lower cylindrical portion, from which they are removed through the door held by the hand-wheel and are then wasted. The enriched liquor is drained through the screen shown below the door with the hand-wheel and carried through the 2-in. pipe to the "crystallizer," which is merely two concrete tanks, each 2 ft. deep.

The refuse is emptied twice during a run. In column F is a typical analysis of the refuse at end of the first half of the run and G at the close, while column H gives the composition of the enriched liquor as collected in the crystallizing vat and H, the anhydrous residue of the same.

SEPARATION OF POTASH

As the solution cools in the crystallizing vats, the potassium chloride and borax crystallize out together and are removed before the solution has cooled sufficiently to throw down the carbonates and sulphates remaining in the liquor. Column I gives a typical analysis of the mother liquor remaining at this stage, which is mixed with refrigerated brine and re-used.

The potash and borax crystals are heated in their

wet state by steam, which causes the borax to dissolve in the water entrained with the crystals and in its own water of crystallization. The potash and dissolved borax are then charged into a centrifuge the moving part of which is a vertical perforated cylinder 26 in. in diameter and 10 in. deep, lined with canvas filter cloth and turned at the rate of 1,350 r.p.m. As the centrifuge revolves, a jet of wet steam is turned into it to assist in driving the dissolved borax through the filter cloth so that the potash crystals are retained in the cylinder. The product that remains in the centrifuge contains about 2 per cent of water and small amounts of the various salts, other than potassium chloride, that make up the natural brine.

The last column (J) in Table I gives an average, on a moisture-free basis, of nine different lots of potassium chloride made by this process. The borax, although small in amount, is recovered in marketable quality. The entire cycle requires about 5 hours after the preliminary chilling.

Two patents have been applied for in connection with this process. One of these covers the process used to check foaming in the evaporator, and the other covers the use of the centrifuge for separating the potash and the borax. The latter has been issued, but the former is still pending.

The process as a whole, as described above, has been adopted by the Inyo Chemical Co. and construction has been started on a plant to have an initial output of 10 tons of potash per day.

I am indebted to Henry W. Carr, president of the Inyo Chemical Co., and to Clinton E. Dolbear, president of the Industrial Research Co., for assistance in collecting the above data and the arrangement thereof.

Legal Notes

BY WELLINGTON GUSTIN

Arkell Patents on Manufacture of Crinkled Paper Held Void for Lack of Invention

The United States Circuit Court of Appeals upheld the decision of the District Court holding the Arkell patents 790,021 and 790,022 void for anticipation and lack of invention, in view of the prior art, and holding his patent 790,023 void for lack of invention. These patents were granted in 1905 on applications granted in 1901, 1903 and 1904 respectively. The court finds that the plaintiff is using rights that belong to the public and are not subject to any monopolistic control under the patents named.

Broadly, the claims of the patents are on the process and on a machine for converting finished paper into stretchable crinkled paper for wrapping and packing purposes. The gist of this process is that the finished paper is first moistened or saturated in one or two baths, smoothed or "laterally stretched" by a convexed roller, pressed against and drawn around a smooth roller, from which it is detached by striking against a blunt blade, called a doctor blade, after which it is pulled off on a carrier so regulated in speed as to leave in the crinkled paper the desired percentage of stretch as the paper is dried.

The court found that crinkling moist paper by the

general method of striking it against a doctor to be old. Such crinkled, stretchable paper was manufactured in substantial quantities by the use of the doctor as early as 1892. The Lysle patent 414,557, of 1889, shows knowledge of this process, as does the English patent 1927, of 1894 to Lower and Edwards (272 Federal R. I.).

It is said that if moistening finished paper so that it will crinkle as paper still moist from the process of manufacture will crinkle involves invention, then Bainbridge's patent 584,108, issued in 1895, covered that point. The court says it makes no difference whether the moistening is done by submerging a roll around which paper is passing, or by running the paper from roll to roll through one or more saturating baths, or by spraying, or by a combination of any or all these processes. To dampen finished paper so that it will crinkle may be done in a great variety of ways, with only ordinary mechanical skill applied to devices in common use for decades.

The court says the "selection and putting together of the most desirable parts of different machines in the same or kindred art, making a new machine, but in which each part operates in the same way as it operated before and effects the same result, cannot be invention.

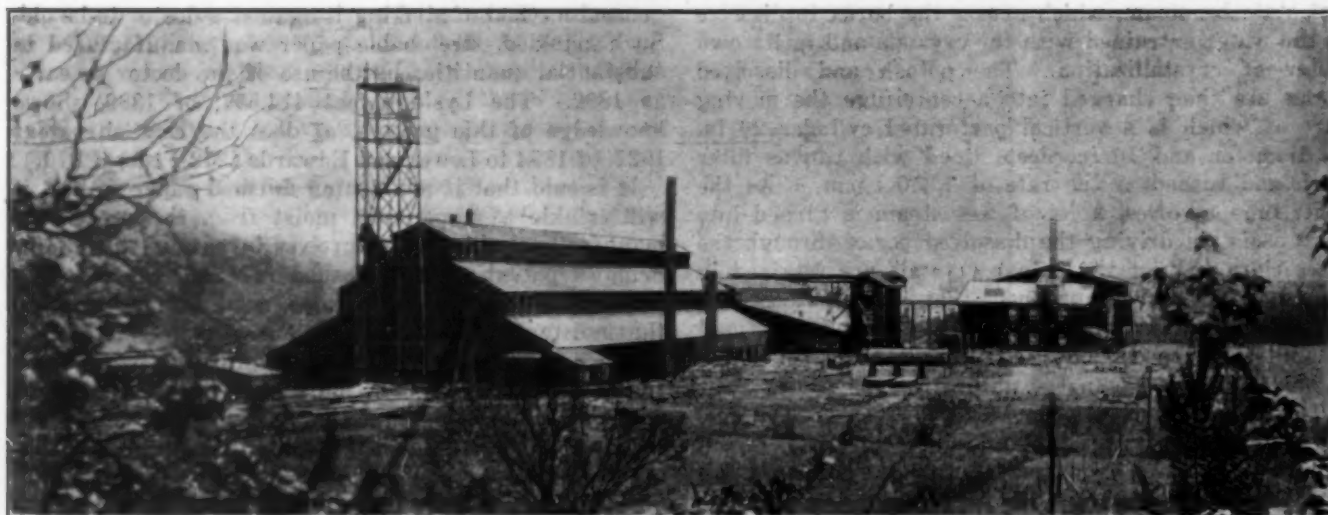
"To sustain a patent on a combination of old devices, it is well settled that a new result must be obtained which is due to the joint and co-operating action of all the old elements."

PRECEDENT OPINION CITED

The advice of the United States Supreme Court in *Atlantic Works vs. Brady* (107 U. S., 192) should be valuable to those interested in patents. It was applied in this case. It says:

"The process of development in manufactures creates a constant demand for new appliances, which the skill of ordinary head workmen and engineers is generally adequate to devise, and which, indeed, are the natural and proper outgrowth of such development. Each step forward prepares the way for the next and each is usually taken by spontaneous trials and attempts in a hundred different places. To grant to a single party a monopoly of every slight advance made, except where the exercise of invention, somewhat above ordinary mechanical or engineering skill is distinctly shown, is unjust in principle and injurious in its consequences.

"The design of the patent laws is to reward those who make some substantial discovery or invention, which adds to our knowledge and makes a step in advance in the useful arts. Such inventions are worthy of all favor. It was never the object of those laws to grant a monopoly for every trifling device, every shadow of a shade of an idea, which would naturally and spontaneously occur to any skilled mechanic or operator in the ordinary progress of manufactures. Such an indiscriminate creation of exclusive privileges tends rather to obstruct than to stimulate invention. It creates a class of speculative schemers who make it their business to watch the advancing wave of improvement, and gather its foam in the form of patented monopolies which enable them to lay a heavy tax upon the industry of the country, without contributing anything to the real advancement of the arts. It embarrasses the honest pursuit of business with fears and apprehensions of concealed liens and unknown liabilities to lawsuits and vexatious accountings for profits made in good faith."



THE BELLE ALKALI CO. PLANT AT BELLE, W. VA.

Up-to-Date Methods in a Bleaching Powder Plant

The Bleaching Powder Plant of the Belle Alkali Co. at Belle, W. Va.—How a War-Born Plant Has Introduced Modern Methods That Help to Overcome the Disagreeable Side of a Standard Method of Manufacture—Industrial Trend Indicated by This Improvement

BY GRAHAM L. MONTGOMERY

UTILIZING the legacy of chemical plants left on our hands as an inheritance from the late war has not proved a uniformly easy task. It has either been necessary for the war-born plant to create a market for a new product in a time of depression or the plant has had to compete with the products of long-established plants in the manufacture and sale of a staple product. Under these conditions there are in general only two cases which have permitted the profitable exploitation of these properties. First, where there is a real demand for a product not formerly made in this country and not at the present time brought in from abroad at an unduly low price; and second, where, through some factor such as location, equipment or organization, the new plant can sell the same product on at least as favorable terms as the old, or can produce a better product to sell on the same terms.

THE BELLE ALKALI CO.

One of the plants where location and equipment have enabled a business to be built up in the face of old-established competition is to be found in the Belle Alkali Co., at Belle, W. Va. This plant was erected by the government during the war for the production of chlorine gas; but was never operated under government supervision, being completed only after the armistice had been signed. Some time thereafter the Belle Alkali Co. was organized, and purchased the plant from the government. The plant was extended and changed to make possible the manufacture of bleaching powder and caustic soda in addition to chlorine.

The object of locating a chlorine plant at Belle is the immediate proximity of a supply of salt. In fact,

the plant stands over the wells, and the brine, which occurs at the 500-ft. level, is pumped up as needed. This gives a supply of the basic raw material of manufacture for chlorine in the desired form without any outlay for shipping. The other principal item needed for the chlorine manufacture is electrical power. Here again the Belle plant is unusually fortunate, as it has on the property sufficient flow of natural gas to supply all power needs at the present, and if in the future the gas wells should run out, there is also on the property a mine of high-grade bituminous coal. Being in the valley bottom of the Kanawha River, a plentiful supply of good water is assured at all times.

From the point of view of accessibility to market, Belle is also rather well situated. It is on the main line of the Kanawha & Michigan R.R., with ready access to the main line of the Chesapeake & Ohio R.R. at a mid-point between the markets of the Central and Eastern sections of the country and also within easy access of the Southern textile markets. In addition, a good labor supply is almost always assured, as the overflow of labor from the extensive West Virginia coal-mining fields should always be sufficient to take care of this need. Here, then, is a plant where all the factors governing sound location seem to be satisfied.

GENERAL MANUFACTURE AT BELLE

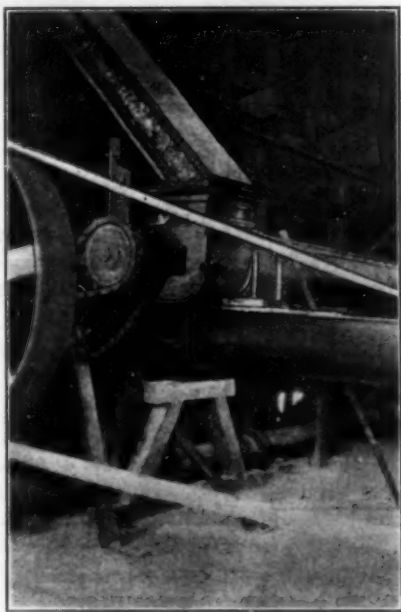
The primary manufacture of this plant was chlorine, by electrolytic methods. This is still the basis of manufacture, and chlorine and sodium hydroxide are the primary products. The market for the chlorine is not sufficient to absorb it all in the liquid or gaseous form and hence a part is now made into bleaching powder. The caustic is sold in the form of flaked

caustic soda, an up-to-date flaking plant having been added to the equipment left by the government.

The bleaching powder plant is the newest addition to the property. It is in building the plant wherein this manufacture occurs that modern and highly efficient mechanical equipment has been adopted. This equipment marks a step in overcoming the usual difficulties under which a bleaching powder plant labors and points the way for a perhaps more extensive use of mechanical methods which will some day eliminate these difficulties altogether. Also, it is largely due to these methods that this company has been able to turn out a good product on such advantageous terms as to assure its place in the market.

MANUFACTURE OF BLEACHING POWDER

The manufacture of bleaching powder has been a standardized process for many years. The only changes that have occurred in this manufacture are refinements in method and are not basic. Briefly, the process consists of bringing hydrated lime into contact with chlorine gas in a suitable chamber, the lime combining with the chlorine to form the bleaching powder. This is a simple process; but it is an intensely disagreeable one for the workers to handle if hand methods are in force for its operation. In the first place, the lime is generally received at the bleaching powder plant in an unslaked condition and must be

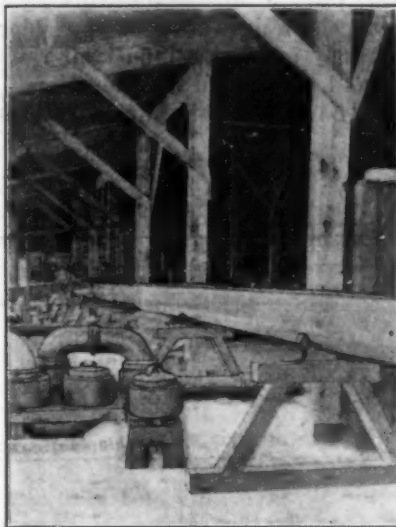


CENTRAL POINT OF LIME-CONVEYING SYSTEM, SHOWING ELEVATOR D AND CONVEYORS 5, 6, 7

hydrated. This slaking is attended by the evolution of heat and gas and there is much dust raised. As a consequence, hydrating machines in which the lime is thoroughly treated with just the correct amount of water have been designed and their use is now general.

After the lime has been hydrated and screened to the proper size it is introduced into the chlorinating chamber or chambers. In its simplest terms, the chlorinating chamber consists of a lead-lined or concrete chamber about 20 ft. in width and from 40 to 100 ft. long and from 6½ to 10 ft. in height. The hydrated lime must be spread over the floor of this chamber, generally to a depth of about 4 in. In order to make a more efficient contact between the lime and the gas,

it is found necessary to scarify the surface of the lime into ridges, until the whole surface is made up of alternate hills and valleys, the sides at an angle of 45 deg. This is a hard job for the workers, for some chlorine is likely to be present in the chamber and the dust from the lime is also unpleasant in effect. In making bleaching powder from the weak concentrations of the gas which result from some of the methods of



CONVEYOR 6, ABOVE CHLORINATING CHAMBERS, ALSO SHOWING CHLORINE DISTRIBUTING SYSTEM

chlorine manufacture, machines have been introduced to do this work mechanically, but with the strong gas available from electrolytic methods these machines do not yet seem to be in the form where continuous and efficient service can be obtained from them. So, for the present at least, this operation remains a hand operation.

DIFFICULTIES IN PACKING BLEACHING POWDER

After the lime has been chlorinated, it remains to remove it from the chlorinating chamber and pack it in the container in which it is to be shipped as the bleaching powder of commerce. To remove the bleaching powder from the chamber it is either raked to one end and hence out or it is raked to chutes leading from the floor of the chamber, the chamber being raised and the containers being loaded underneath. It is scarcely possible to get all the chlorine gas out of the chamber and there are always fumes and deleterious dust given off from the powder, so that the work of emptying the chamber is extremely trying. The powder is then to be packed into containers and these containers to be sealed before shipment. In this last process, more or less dust always escapes from the chute and container and gets in a paste on the floor of the packing room. This paste is an active oxidizing agent, and causes rapid deterioration of everything with which it comes in contact that may be oxidized. Also, there is a certain amount of chlorine which escapes from the bleaching powder when it is freed to the air, and this adds to the difficulties in this part of the work.

In most plants in this country today the lime in both the slaked and unslaked state is handled by mechanical equipment from its receipt in the plant through the hydrating process, the screens and to the chlorinating chamber. Due to the activity of the material beyond this point in oxidizing the usual metals of which

handling equipment is made, no attempt is made to use any machinery beyond the entrance to the chamber. This is with the exception that several plants have installed an industrial railway under the chambers. In this case, the container is filled while on a car and is then pushed to the header and the scales and so to shipment or storage as desired. This method employs about as much labor as the full hand method, does not save a great deal of time and is subject to the same labor turnover, due to unpleasant working conditions, that causes the chief drawback of the older methods. Also, the relatively expensive industrial railway equipment is subjected to a rapid deterioration.

At Belle this later succession of operations—i.e., the

into the raw crushed lime storage bin. As the discharge into this bin is at one point only, it is necessary to have a means of distribution in order to utilize to full advantage the available storage space of the bin. This end is accomplished by the conveyor marked 1 on Fig. 1, which is a screw conveyor running open within the bin at the top and along the longitudinal center line.

From one side of the bottom of the raw crushed lime bin are three spouts which may be regulated to deliver an exactly determined amount of lime to the conveyor marked 2. This conveyor is a screw conveyor housed in a dustproof housing. The bottom of the bin is sloped to the side from which the discharge is taken so that the bin may be cleared without anyone going inside. Con-

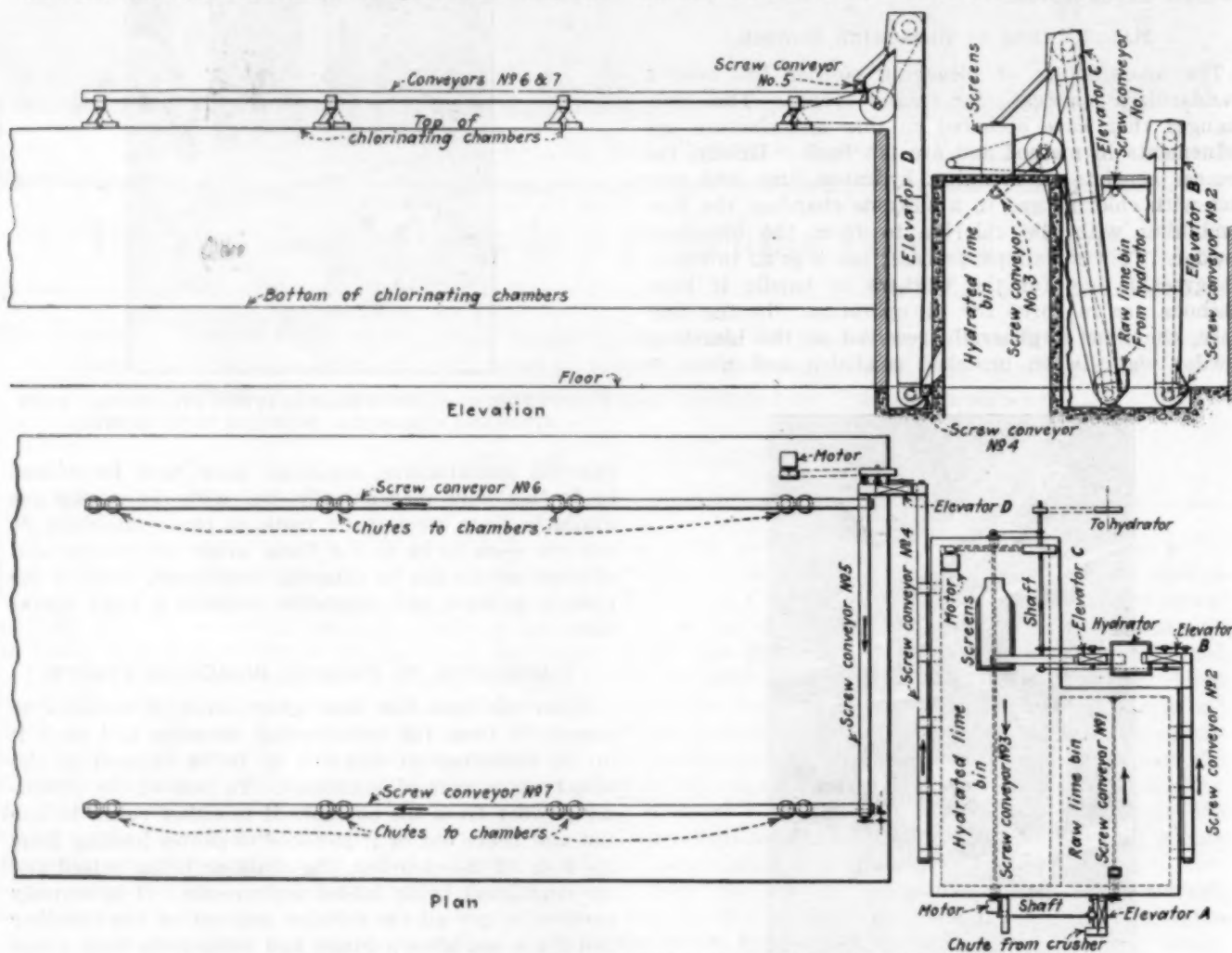


FIG. 1—CONVEYING SYSTEM FOR TAKING LIME TO THE CHLORINATING CHAMBERS

filling of the container and all the subsequent handling—has been made as nearly automatic as possible. Thus one more of the disagreeable factors that cause a high labor turnover and hence a high labor expense in this manufacture is on the way to solution, and one more cause of industrial disability is at least partly removed.

MAKING BLEACHING POWDER AT BELLE

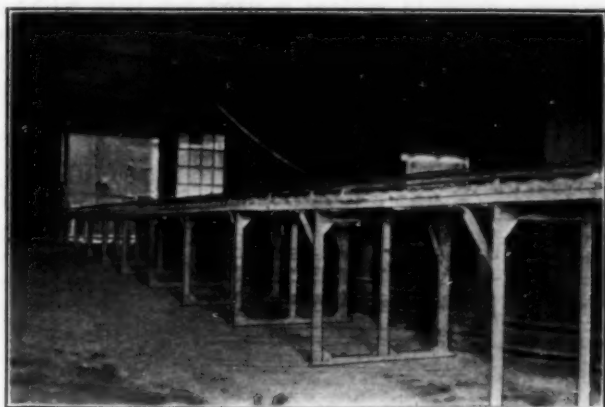
At Belle the unslaked lime is delivered in cars on the siding adjacent to the lime crusher shown in Fig. 1. This lime is unloaded by means of a portable belt conveyor directly to the hopper of the lime crusher. After passing through the crusher, the lime is delivered to the boot of the bucket elevator marked A on Fig. 1. This elevator, which has a dustproof casing, raises the lime a total distance of about 28 ft. and discharges it

veyor 2 delivers to the boot of bucket elevator B, also shown on Fig. 1, which is a standard bucket elevator housed in a special dustproof casing. Elevator B delivers the crushed lime to the hydrator. This is a mechanically driven hydrator wherein the lime is treated with the exact quantity of water necessary to slake it thoroughly and to leave it in the proper state for use in the chlorinating chambers except for the screening operation.

The lime, in being hydrated, passes down through the hydrator and is delivered from it into the boot of bucket elevator C at a point near the floor level as shown in Fig. 1. This elevator, like the others a standard elevator in a special dustproof casing, elevates the hydrated lime and introduces it into the screens. Here the material which is sufficiently fine is passed into the

hydrated lime storage bin by means of gravity chutes, while the small quantity which is too large is rejected to be reworked. A distributing conveyor, marked on Fig. 1 as conveyor 3, runs open in the top of this bin in the same manner as conveyor 1 runs in the raw crushed lime storage bin. The hydrated lime storage bin is a concrete bin similar to the raw crushed lime bin, with a sloped bottom to facilitate delivery of the lime. The gates of the spouts through which the lime is withdrawn are not in this case, however, of the regulating type, as there is no particular object in keeping strict account of the amount of lime taken from this bin.

The spouts in the bottom of the hydrated lime storage bin feed the screw conveyor marked 4 on Fig. 1. This conveyor delivers the lime to the boot of bucket elevator *D*, a standard elevator in a dustproof casing which raises the lime to a point about 40 ft. above the floor of the room, which is a sufficient height to deliver the lime by



GRAVITY CONVEYOR UNDER CHLORINATING CHAMBERS

gravity to the distribution system, which takes it to the different chlorinating chambers. This distribution system consists of a screw conveyor marked 5 on Fig. 1, which takes the lime from elevator *D* and delivers it to either screw conveyor 6 or screw conveyor 7. These two conveyors are located on top of the chlorinating chambers one about 10 ft. back of either face, and are sufficiently elevated to deliver the line through spouts by gravity into the chambers.

The chlorinating chambers are of concrete through-out and are 20 x 60 ft. by 10 ft. high. They are arranged in two tiers of four each, making a total of eight chambers, and have a clearance above the working floor under the lower chambers of about 10 ft. In each end of each chamber is a door of wireglass in a wooden frame which can be sealed gas tight and through which the process can be watched. These doors also permit the workers to enter when the lime is to be spread or the finished powder to be removed. The lime is introduced by means of two separate spouts for each chamber, one leading from conveyor 6 and one from conveyor 7. The chlorine is introduced through an appropriate system of tile piping under a slight suction, which is utilized at the close of the process for a means of exhausting any excess gas from the chamber. The finished powder is removed by means of four chutes leading from each chamber on the longitudinal center line and extending down to a point immediately above the highest point to which a container resting on the conveyor in the working space beneath would reach. It is still found necessary to do all the work of spreading the lime in the chamber preparatory to chlorinating and of raking up the finished powder and directing it

down the chute to the container by hand. This is a disagreeable job and one attended by some danger, as the concentration of chlorine present, even with the utmost care, may sometimes exceed that which can be well withstood by the human system. The chambers are, however, exhausted until the continuous test on the exhaust gases does not show a trace of chlorine, and it is only chlorine that may be given up from the powder that causes the trouble. Besides this, all workers in the chambers wear an air helmet.

HANDLING THE FINISHED PRODUCT

Directly under the chlorinating chambers is situated the conveying system used for loading, sealing and weighing the containers and delivering them to the shipping dock, and shown on Fig. 2. This is a new application of conveyors. Formerly, due to the oxidizing action of the bleaching powder, which it is impossible to keep off of any conveying system, it has not been thought feasible to introduce conveyors at this point. The system used here consists of a specially designed gravity roller system. In order to provide against corrosion as much as possible, this conveyor system has been made especially heavy in construction, a fact that was also made necessary by the heavy weight of the containers when filled with the powder, this weight going up to about 800 lb. It is expected that the frame, which is of heavy angle-iron construction, and the rollers, which are made of special heavy steel tubing, will withstand the effect of the bleaching powder for about 3 years. The particularly hard problem to be overcome was to get a free working bearing that would not be destroyed by the corrosive action.

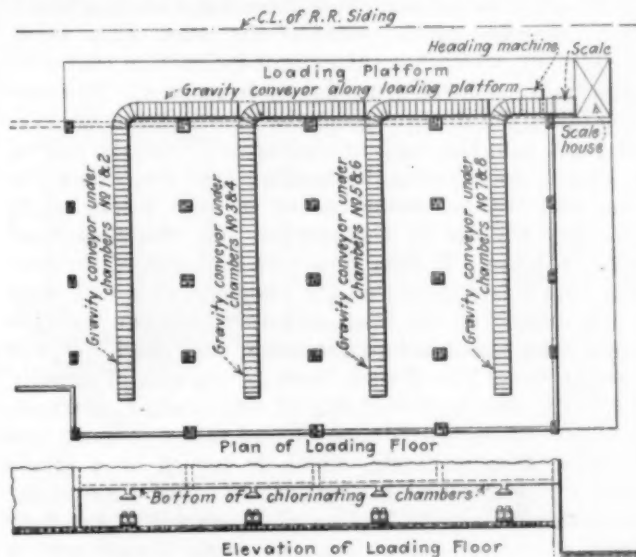


FIG. 2—CONVEYING SYSTEM FOR HANDLING FINISHED BLEACHING POWDER

This problem has been solved in the following manner: The end caps of the rollers have been made of heavy cast iron. In this casting a ball bearing is embodied, which is protected from the gas by having all joints threaded. Even with this precaution, there are openings into the bearing where the shaft goes through and where the means of lubrication is provided. In order to overcome this, an experiment has been tried which after nearly 6 months' use has been proved satisfactory. The bearings are all provided with Alemite lubricators, as shown in the accompanying illustration. This is a lubricator originally designed for use in automotive work, where it is necessary to introduce



HEADING MACHINE, SCALE AND LOADING PLATFORM

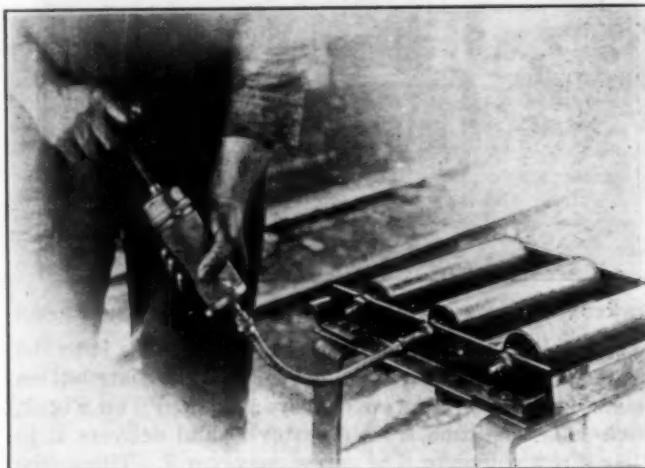
the lubricant under pressure. In this case, the initial pressure under which the lubricant is introduced serves to keep any of the fumes from the powder from entering the bearing and the only precaution that has been found necessary is to keep the bearing well filled with this pressure lubricant.

The method in which this gravity conveying system is used is as follows: An empty container, which is in this case a large steel drum with one head removed, is placed on the gravity directly under one of the chutes leading from the chlorinating chamber above. A canvas extension is attached to this, leading down into the drum, which serves the purpose of preventing the bleaching powder from scattering while the drum is being filled. The gate in the chute is then opened and the drum is filled to the required height. The gate is then closed, and the canvas extension chute removed. Then, without any disturbance of the powder, the drum runs along the conveyor, which has such slight inclination that it is necessary to push the drum lightly to move it. The conveyor takes the drum around the curve shown on Fig. 2 and out onto the loading platform. Near the end of the gravity conveyor is the heading machine, where the drum, still without being moved in such a way as to cause any spillage of the powder, has the steel head sealed in place. It then runs onto a section of the conveyor which is situated on the platform of a dial scale and the weight of the filled container is taken, the tare having been noted before the drum was filled. It will be noted from Fig. 2 that there is one run of gravity conveyor under the center line of each tier of chlorinating chambers and that these all feed into a common line on the loading platform, which is served by a single heading machine and a single scale. The floor under the chambers and the loading platform are at car floor height so that the drum may be easily tipped onto a hand truck as it leaves the scale and wheeled into the car or stacked in some of the extra space under the chambers which serves as a storage reservoir for drums awaiting shipment. Special hinged sections are provided in the gravity conveyor along the loading platform so that these may be raised and the drums which are to be stored wheeled back into the building.

ADVANTAGES OF THIS SYSTEM AND ITS SIGNIFICANCE

The most important advantage following the use of this conveying system for loading drums and handling them to shipment is that it is possible in this way to handle a greater volume in a given space and still maintain much cleaner working conditions than is the case with either the industrial railway or the hand methods.

This is of real importance, as the conditions in this packing space are generally so disagreeable as to make the turnover among the employees overhigh, so high, in fact, that the cost of the work is unduly increased through breaking in new men and through delays incidental to having at times an inefficient crew. The gravity conveyors have been in service a sufficient time to prove their workability, and it is apparent that, even though the effect of the corrosion does cause them to wear out in a much shorter time than they would in other circumstances, the savings made through their use will more than make up for the replacement charges and the benefits derived from making the plant a healthier and safer place for men to work in will have a reflex action on plant conditions in general which will be felt throughout the plant. There is also to be considered that a gravity conveyor involves no operating charges for power and that it is the cheapest form of conveyor from the maintenance standpoint. All the parts are standard and it is very simple to replace a worn-out part without delaying the use of the conveyor for any appreciable time. This is one of the cases where it is better practice to employ a cheap and simple conveyor, even if it



SPECIAL ALEMITE LUBRICATION FOR GRAVITY CONVEYORS

does wear at what seems on first glance to be an unduly high rate, than it is to struggle along under the increased labor expense and burden of management which follow if the conveyor is not used.

It is worth while pointing out that such an installation as is described above indicates a tendency that is coming more to the fore in industry at the present time than it has ever before. That is the tendency to introduce refinements into present methods of manufacture which will make them more economical and safer to operate rather than to seek some entirely new way of doing things. It is to be hoped that such a tendency will not increase to a point where legitimate pioneering is discouraged; but it is a fact that in general the best profits are to be found in making a product for which there is already a good market in the most economical and best way. Very often this best way is to be sought rather in the refinement of an existing process than in the development of a new one.

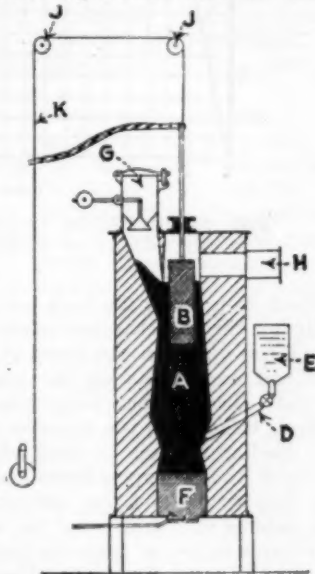
The writer desires to express his thanks to the management of the Belle Alkali Co., for permitting the above information to be gathered at its plant; and to thank the Alvey-Ferguson Co., which manufactured the conveyors described herein, for the layouts here reproduced.

Recent Chemical & Metallurgical Patents

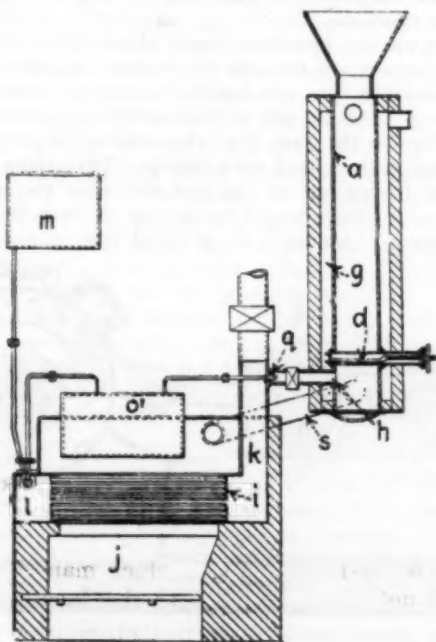
British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Building, Chancery Lane, London, England.

Carbon Bisulphide.—Apparatus for the production of carbon bisulphide comprises a shaft, *A*, provided with two electrodes, *B*, *F*, the latter being adjustable by means of the rope *K* and the rollers *J*. The adjustable electrode *B* rests freely on the layer of charcoal in the shaft, and is also surrounded by coal supplied through the hopper *G*. A moderate voltage between the two electrodes raises the temperature of the carbon column sufficiently to cause a brisk reaction between it and the sulphur, which enters through pipe *D* from heated vessel *E*. The sulphur enters near the constriction in the shaft which is the hottest region. Products pass away through the flue *H*. (Br. Pat. 174,040. Not yet accepted. Chemische Fabrik Griesheim-Elektron, Frankfurt-on-Main. March 8, 1922.)



Gas Manufacture.—Coal or other carbonaceous material is treated in an externally heated retort with a gas containing 60 to 70 per cent of hydrogen or with a mixture of such gas and superheated steam at a temperature of from 500 to 600 deg. C., whereby an increased yield of condensable hydrocarbons, ammonium sulphate and coke is obtained. The coal is charged into a vertical retort *a* inclosed in a wall and having a perforated valve *d* for admission of the gases and for discharging the coke. Hydrocarbon oil, a byproduct of the process, from a tank *m* is sprayed with steam from a boiler *o'* into a vaporizing-chamber *l*, from which the mixture enters and is heated in iron pipes *i* com-

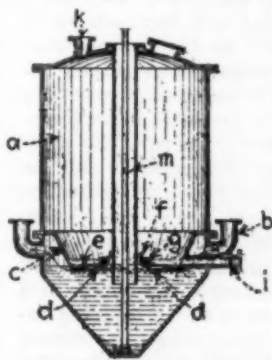


municating by a conduit *k* with the inlet *h* of the retort *a*. Superheated steam may also be supplied from a nozzle *q*. The hot gases from the furnace *j* serve to heat the pipes *i* and pass by a flue *s* to the space *g* around the retort. The distillation products leave the retort by an outlet and a rotary ram, having ribs on its under side and operated by a hand wheel serves to consolidate the fuel in the retort if required. To obtain a hard coke, during the last 20 to 30 minutes of coking the gas and steam, or steam alone, may be introduced at a temperature of from 700 to 900 deg. C. (Br. Pat. 174,165. J. Moeller, of Devon, and L. di Fonblanque, of Farnham, England. March 15, 1922.)

Carbonizing.—Carbonaceous materials such as lignite, brown coal and peat are powdered, mixed to form a paste with a hydrocarbon such as creosote, and ground to colloidal dimensions, the mass being then ground with coal tar or the like to form a liquid as described in specification 172,065. This colloidal liquid is passed under a pressure not exceeding 25 atmospheres through piping of small bore heated to not exceeding 500 deg. C. and is injected into a chamber in which vaporization takes place. The vapors are condensed and the permanent gases separated, leaving a liquid which may be used for fuel or may be further vaporized in the chamber, a semi-liquid mass remaining which is suitable as a binder for briquets, or, on still further vaporization, a residue from which briquets are formed is obtained. These briquets may be distilled to produce gas, coke, etc., or may be used in a gas producer. (Br. Pat. 175,670. G. P. Lewis, Westminster. April 20, 1922.)

Tanning.—After mineral or vegetable tanning, hides are soaked in an aqueous solution of pyridine to fix the tanning elements and permit subsequent washing and rapid drying without sweating or exudation to cause streaking or discoloration. The hides are usually soaked for 4 to 12 hours in a 10 to 25 per cent solution of pyridine. (Br. Pat. 175,362. T. B. Carmichael of Waterloo and W. H. Ockleston of Kelsall, England. April 12, 1922.)

Ammonium Sulphate.—A saturator, for use more particularly in the manufacture of ammonium sulphate, is constructed so that the passage of gas through the liquid is mainly horizontal. The saturator *a* is fitted with a bell *c* beneath the upper edge of which are the gas inlets *b*. The lower edge *d* of the bell is serrated, and extends for a short distance only below the level of the liquid in the saturator. The bell is fitted with a disk *e* by means of which the gas is made to traverse a radial path until it escapes through the aperture *f*. The edge of the bell is kept free from salt incrustations by means of a sprinkler tube *g*, the liquor from which flows through apertures and is kept at constant level by the overflow *i*. The gas finally leaves through the outlet *k*, and the salt is discharged through the siphon *m*. (Br. Pat. 175,649. Not yet accepted. H. Egeling, Weitmar, Germany. April 20, 1922.)



Depilation of Hides.—Relates to the depilation of hides and skins in closed chambers by the action of heat and gaseous ammonia and consists in the use of ammonia in concentration of approximately 150 to 300 g. per cu.m. of chamber capacity and at temperatures of about 37 to 45 deg. C. The hides are previously soaked or wetted according to condition and are hung in a chamber, steam being admitted to raise the temperature and maintain a degree of humidity. Ammonia is admitted at the same time in the concentrations indicated and after 3 to 6 hours, when the roots of the hairs have been slackened, the ammonia is expelled from the chamber and that remaining in the hides is dissolved by rinsing either in the form of ammonia or after conversion into a suitable salt, such as ammonium carbonate, by admission of carbon dioxide or flue gases. The hairs are removed by hand or mechanically, the hides being kept warm by immersion in warm water or otherwise until the depilation has been effected. (Br. Pat. 175,314. O. Richter, Brandenburg. April 12, 1922.)

Synopsis of Recent Chemical & Metallurgical Literature

A High Pressure, Yielding-Plunger Pump for Vegetable Oil Expression.—Joseph Davidson of Atlanta, Ga.¹, speaking before the recent meeting of the American Society of Mechanical Engineers, described a new type of pressure pump that is being successfully used in connection with the extraction of vegetable oils by hydraulic pressure. The manner of applying the pressure has an important bearing on the efficiency of the expression process and also in the economy of the cloth used for covering the oil-bearing materials. The new pump is described as a high-pressure yielding-plunger pump and is claimed to represent a decided improvement in the hydraulic method.

A simple low-pressure pump is also used with plungers having a constant stroke, working in connection with a weighted accumulator and bypass valve, which maintains a pressure of approximately 600 lb. per sq. in. This supplies the pressure in large volume up to 600 lb. per sq. in. on all presses, and also supplies the pressure for operating the machine that forms the material into cakes, preparatory to being put into presses.

Referring to Fig. 1, the eccentric *A* imparts a reciprocating motion to the crosshead *B*. Yoke *C* is connected to crosshead *B* by means of two rods (one on either side, not shown in this figure) and moves fixedly with crosshead *B*. The two plungers *D* are fitted loosely, one in *B* and the other in *C*. Each plunger *D* has a collar *E* fitted against a shoulder. Between these collars *E* and the crosshead *B*, in one case, and the yoke *C* in the other, is placed a double-coil spring *F*, which receives the thrust of the plungers. The initial tension in the springs will stand a pressure of approximately 1,800 lb. per sq. in. against the plunger without yielding, but when the pressure in the pump barrels *G* reaches 1,800 lb. per sq. in., the springs will begin to yield, and continue to do so more and more as the pressure increases. Thus the stroke of the plungers is gradually reduced until the maximum pressure is reached, when they will cease to move; then the maximum pressure is held constant until the extraction of the oil is completed. The pressure is then released, and the cakes are discharged from the press, which is then refilled for another pressing operation.

Each chamber *I* around the discharge check has a $\frac{1}{2}$ -in. discharge connection, and the common practice in applying pressure to vegetable-oil presses is to run a separate and independent $\frac{1}{2}$ -in. pipe from each discharge connection to a press. Thus the high pressure on each press is supplied independently by one plunger, the pumps being constructed so as to provide one high-pressure yielding plunger for each press to be served. These $\frac{1}{2}$ -in. high-pressure pipes are connected directly to each press cylinder, no valve being required to cut off the pressure. Each press is equipped with an inlet valve for low pressure and a discharge valve; also

¹Davidson & Kennedy, oil mill engineers and manufacturers. Mem. Am. Soc. M. E.

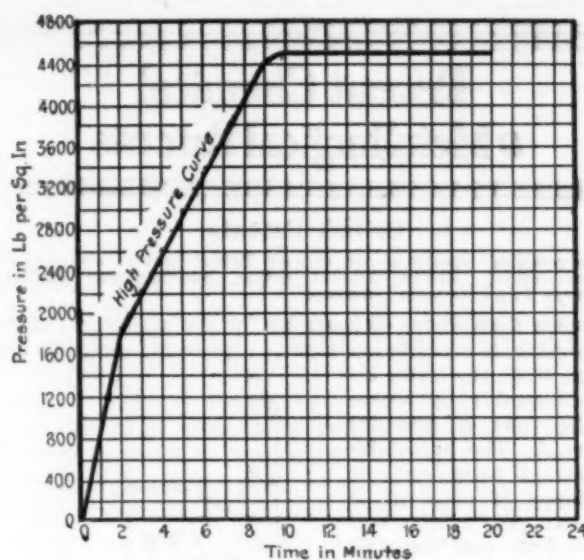


FIG. 2—PRESSURE CURVE WITH PLUNGERS WORKING AT 60 STROKES PER MINUTE

a check to prevent the high pressure from leaving the press cylinder through the low-pressure inlet valve. When the discharge valve on the press is closed, the high pressure is confined and builds up the pressure to the maximum required. The springs supporting the plungers are then in action, taking up the movement of the crosshead. When the discharge valve is open while the cakes are being discharged and the press boxes refilled, the plungers are moving full stroke and the springs are not being compressed; the volume of liquid being moved by these plungers merely circulates under no pressure through the press cylinder, and out of the open discharge valve, back into the tank supplying the liquid to the suction of pump.

The use of this pump in supplying pressure to the presses used in the vegetable-oil industry obviates the necessity for any outside controlling devices such as safety valves, retarding, or choker valves, etc.

The power required is the minimum for the amount of work being done. The peak load comes when the pressure reaches 1,800 to 2,000 lb. per sq. in., and while the plungers are still moving full stroke. But from the moment the plungers begin to yield and the pressure continues to rise until it reaches the maximum and the plungers cease to move, the power required decreases; so that the maximum pressure is maintained with little more power than is actually necessary to overcome the friction of the moving parts of the machine.

Fig. 2 shows the pressure curve obtained by this pump when the plungers are making 60 strokes per minute.

This constantly and gradually increasing pressure, especially above 1,800 lb. per sq. in., obtains the maximum oil extraction due to the fact that the density of the material being pressed is increased very slowly. This gives time for the oil to be forced out of the material with the least possible resistance which would be set up in case the density was increased too suddenly by a rapid rise of pressure.

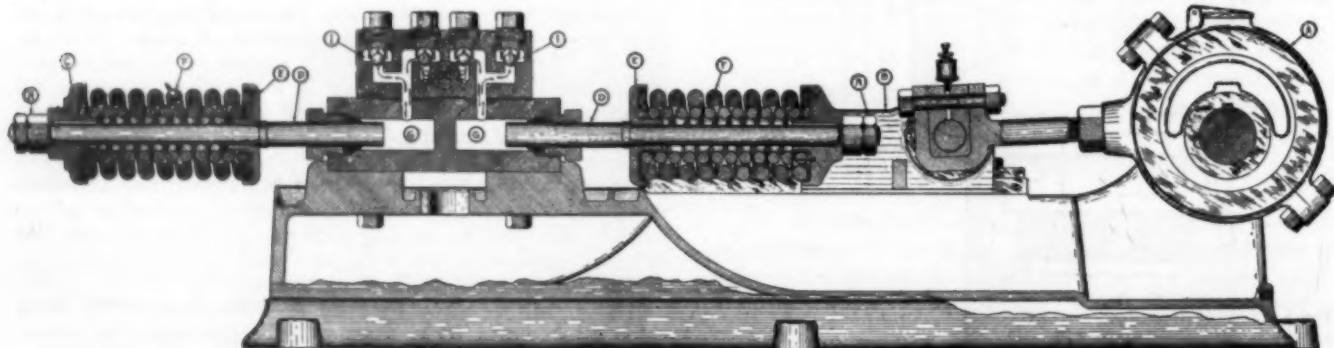


FIG. 1—LONGITUDINAL SECTION THROUGH HIGH-PRESSURE PUMP WITH YIELDING PLUNGERS

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Appropriations Announced for Chemical Projects of Department of Agriculture

The appropriation bill carrying funds for the Department of Agriculture for the year beginning July 1 is now a law, having been approved by the President. For the Bureau of Chemistry the bill appropriates a total of \$1,277,631, of which \$954,561 is for various investigations and \$323,070 for administrative expenses.

Among the appropriations made are the following: Investigations relating to the application of chemistry to agriculture, \$75,400; co-operation with other government departments desiring chemical investigations, \$14,000; investigation and experiments in utilization for coloring, medicinal and technical purposes of raw materials grown or produced in the United States in co-operation with persons, associations or corporations, \$56,260; investigations to determine methods for manufacture of table sirup and sugar and methods for manufacture of sweet sirups by utilization of new agricultural sources, \$15,000; enforcement of food and drug act, including investigation of character of chemical and physical tests applied to American food products in foreign countries, \$671,401; enforcement of act forbidding importation of impure tea, \$38,000; investigation of naval stores, \$10,000; investigation and development of methods of manufacture of insecticides and fungicides, \$20,000; study and improvement of methods of dehydrating materials used in food, \$20,500; investigations to prevent grain dust and other plant dust explosions, \$25,000; investigation and development of methods of utilization of wool scouring, \$9,000.

The Bureau of Soils is given \$23,110 for chemical investigations of soils and \$70,000 for fertilizer investigations.

The Bureau of Public Roads is given \$175,000 for investigation of chemical and physical character of road materials and \$15,000 for supervision of distribution of picric and other acids in clearing lands. For enforcement of the insecticide act \$31,500 is provided for salaries and \$156,510 for general expenses.

Sentiment Favors Embargo on Helium Exports as Military Precaution

Legislation proposing an embargo on helium exports, which soon is to be considered by a committee of the House of Representatives, differs from embargoes on commercial articles, it is pointed out, in that helium is primarily a weapon of warfare. Moreover, it is a weapon on which the United States has a monopoly. It seems to be the consensus among army and navy officials concerned with helium that it would be foolish to permit the exportation of this gas to a possible enemy.

The helium bill, it is further pointed out, does not put the government into business. There are numerous precedents in which the government develops fundamental facts and brings a process to the point where it can be developed commercially. In the case of helium, the cost of experimental work and the uncertainty as to its outcome would have precluded exploitation of helium resources by private capital indefinitely.

Syracuse Section, A.C.S., Elects

At a recent meeting of the Syracuse, N. Y., Section of the American Chemical Society held at Syracuse University the following officers were elected: A. C. Houghton, Solvay Process Co., president; Prof. Ross A. Baker, Syracuse University, vice-president; L. C. Jordy, Syracuse University, treasurer, and William Hicks, secretary.

Five-Year Course for Engineering Students Favored by Conference of Educators

Five year courses for students in engineering were favored by the deans and representatives of fourteen colleges at a conference held in Chicago, May 19. It was agreed that the first four years should be broadened to include more fundamental subjects and less highly specialized engineering and the last year should be devoted to intensive specializing in the chosen field. It is hoped that this concerted action will bring about the publication of the new courses of study in time to be effective not later than 1924. The resolutions embracing the conclusion of the conference follow:

The undersigned engineering deans, directors and representatives, in conference assembled, hereby

Resolve: That in order to meet the constantly enlarging responsibilities of the engineering profession we favor an advance in engineering education at this time that shall provide for five years of collegiate training for those engineering students whose aim is to be qualified to take positions among the creative leaders in the profession, and that such advance shall be made in substantial accordance with the following plan:

1. Remodel the present four-year engineering curriculums by substituting a substantial proportion of humanistic and fundamental subjects in place of an equivalent amount of advanced technical work. It is desirable that so far as possible the curriculums in the different branches of engineering shall be sufficiently uniform to permit students to defer their final choice of a specialty at least to the end of the second year.

2. Add a fifth year of advanced work, mostly or wholly technical and specialized to such an extent as desired.

3. The first four years of work shall lead to a bachelor's degree, and the fifth year to an advanced degree in engineering.

Resolved: That each member of this conference will present the above recommendations to the authorities of his institution, and will report back at the second session of this conference, which is to meet at Urbana, Illinois, during the week of June 18, 1922, on call of the chairman.

Dean W. G. Raymond, State University of Iowa, Iowa City, Iowa, chairman; Dean O. N. Leland, University of Minnesota, Minneapolis, Minn., Secretary; Dean E. A. Hitchcock, Ohio State University, Columbus, Ohio; Dean A. A. Potter, Purdue University, Lafayette, Ind.; Dean M. E. Cooley, University of Michigan, Ann Arbor, Mich.; Dean G. W. Bissell, Michigan Agricultural College, Lansing, Mich.; Dean C. R. Richards, University of Illinois, Urbana, Ill.; Director J. F. Hayford, Northwestern University, Evanston, Ill.; Prof. Edward Bennett, University of Wisconsin, Madison, Wis.; Dean E. J. Babcock, University of North Dakota, Grand Forks, N. D.; Dean O. J. Ferguson, University of Nebraska, Lincoln, Neb.; Dean Anson Marston, Iowa State College, Ames, Iowa; Dean W. E. McCourt, Washington University, St. Louis, Mo.; Dean H. S. Evans, University of Colorado, Boulder, Col.

Aluminum Company Sues on Nitro Sale

The International Aluminum Co. has filed suit in federal court against the Charleston Industrial Corporation, the Virginian Power Co., A. B. Leach & Co., James Douglass, H. G. Scott, D. C. Schaeffer, C. S. Jenner and W. B. Payne, in connection with the transaction by which the federal government sold its \$125,000,000 war-time explosive plants at Nitro for \$3,000,000.

The International Aluminum Co. is asking damages of \$50,000.

Better Progress on Tariff Bill—Dye Schedule Will Meet Opposition

Reports from Washington as to the chances of the passage of the tariff bill are more encouraging. Republican leaders believe that the filibuster is about spent and look for more rapid progress from this time forward, with the prospects favoring the passage of the bill late in July. Most of August would be required for the conference between the two houses. There are some who do not expect to see the bill become a law until after the November elections, but the consensus among Republican leaders is that the new tariff act will bear a September date.

MAY ABANDON DYE EMBARGO

It is expected that Democratic opposition to the dye provisions of the tariff bill will get a great deal of Republican support. Senator George H. Moses of New Hampshire, Senator La Follette of Wisconsin and possibly Senator Lenroot of that state and Senator Norris of Nebraska may line up against the Republican program of protection for the dye industry. Senator Smoot of Utah is opposed to the embargo.

In the event that Senator Frelinghuysen of New Jersey, who is leading the proponents of the embargo plan, fails to "sell his idea" to the Senate it is probable that this type of protection will be dead for all time. High rates, however, will be provided and little or no opposition will be raised to protection by tariff rates.

PROTESTS ON POTASH RATES

Senator Heflin of Alabama opposed the tariff on arsenic potash and fertilizer on the ground that it would be a burden to the farmers. Other protests on fertilizer rates are being registered by a committee of the National Fertilizer Association, which, on a platform of "free plant food," is in Washington favoring the free importation of potash, ammonium sulphate and nitrogenous waste of leather and tanning factories. The committee consists of Horace Bowker of New York, W. D. Huntington of Baltimore, F. H. Whipple of Hartford and J. Russell Porter of Atlanta, president of the Southern Fertilizer Association.

The Southern Fertilizer Association, through its president J. Russell Porter, has entered a protest against the potash tariff in a telegram to the House Ways and Means Committee.

"The Southern Fertilizer Association is strongly against a potash tariff," says the protest. "The burden of such a tariff will fall heaviest upon the Southern cotton farmer, and anyone at all familiar with the condition of the cotton farmer knows he is not able to bear it. Not only has the Southern farmer suffered heavily in consequence of the reverses of the deflation period, but on top of that has come the greatest disaster from the boll weevil ravages that the South has ever experienced.

"The cotton farmer is heavily in debt. His rehabilitation largely depends on fertilizers, and every cent added to the cost of fertilizers by the Fordney tariff bill will delay the time and increase the difficulties of his recovery.

"According to the provisions of the Fordney tariff bill, the cotton farmer must pay \$25 more per ton on his sulphate or muriate of potash than he would pay if there were no tariff. It means just that much handicap to the cotton farmer in fighting his way back to prosperity.

"The tobacco farmer and truckers, though not in as deplorable a condition as the cotton farmer, would feel the tariff keenly, because these crops require large amounts of potash."

PAINT AND PIGMENT SCHEDULES PASSED

The Senate adopted the duty of 28 cents a pound on vermilion reds containing quicksilver, rejecting a motion of Senator Simmons of North Carolina to reduce it to 15 per cent ad valorem, by a vote of 18 to 31.

The duty of 30 per cent on paints, colors and pigments was adopted by the Senate, which on motion of Senator Smoot, for the Finance Committee, struck out the provision that any of these articles composed in chief value of coal-tar dyes or colors shall be classified under the coal-tar

products schedule at 60 per cent ad valorem and 7 cents a pound.

On motion of Senator Smoot the Senate reduced the duty on strontium from 50 to 25 per cent ad valorem on the ground that the product is virtually controlled in this country by one concern.

The Senate then voted on various lead pigment duties, defeating by 21 to 47 an amendment of Senator King reducing the litharge duty from 2½ to 1½ cents a pound, and then adopting the 2½-cent duty.

Senator Jones of New Mexico argued that there was no justification for a duty on lead pigments, except the compensatory duty for the lead ore duty. An amendment by him to reduce the red lead duty from 2½ to 1½ cents a pound was defeated, and the 2½-cent duty adopted. An amendment by Senator Jones reducing the white lead duty from 2½ to 1½ cents a pound was also defeated 19 to 47.

On motion of Chairman McCumber, the Senate reduced the duties on chrome colors in paragraph 67 from 30 to 25 per cent ad valorem, defeating an amendment by Senator King to reduce them to 20 per cent, by a vote of 20 to 46. The duty on iron oxide and iron hydroxide pigments was reduced from 25 to 20 per cent ad valorem. By a vote of 21 to 42 a motion by Senator Underwood of Alabama to reduce the duty to 10 per cent was rejected.

Following extended debate in which the rates were attacked by Senator Jones of New Mexico, the Senate adopted the zinc oxide rates. The rates adopted are 1½ cents per pound on zinc oxide and leaded zinc ores containing not more than 25 per cent of lead; ground or mixed with oil 2½ cents per pound; lithopone 1½ cents a pound.

On motion of Senator Smoot, the duty on thorium nitrate and oxide was reduced from 45 to 40 per cent. The duty on tin compounds was fixed at 25 per cent ad valorem, the Senate rejecting by a vote of 14 to 39 a motion of Senator Jones of New Mexico to reduce it to 10 per cent. The antimony salts duties as recommended by the committee were also adopted.

Army Engineers Urge Hydro-Electric Development of Tennessee River

The mineral resources and power possibilities of the Tennessee River and its tributaries in North Carolina, Tennessee, Alabama and Kentucky are the subject of exhaustive reports of army engineers transmitted to Congress. Reference is made to possible power developments on the river from Chattanooga to Riverton; and at Coulter Shoals, 40 miles below Knoxville. Recommendation is made that a more detailed survey be authorized looking to development of the rivers for navigation and power purposes.

The reports show that a large amount of hydro-electric power is now wasted annually in the upper section of the Tennessee River. It is stated that at Coulter Shoals a minimum 24-hour capacity of 14,000 hp. can be developed. Its transmission would be principally to Knoxville, where there is said to be a demand for power in excess of the supply. It is stated that for 90 per cent of the time in an average year 18,400 hp. would be available, while for 57 per cent of the time from 40,000 to 44,000 hp. may be developed. The initial cost of the project at Coulter Shoals is estimated at \$6,346,500 and \$257,300 annually for operation if built by the government. If built by private enterprise, the initial cost would be increased by \$400,000.

Association of Chemical Equipment Manufacturers Announces Committee on Exposition Plans

A committee has been appointed by Dr. C. H. Kimberly, acting chairman, to work out plans for the future exposition exhibits of the Association of Chemical Process Equipment Manufacturers. The association was organized at a meeting in New York on May 11.¹

The personnel of the committee is as follows: W. W. Smith of the Duriron Co., chairman; A. H. Stevens, of the Bethlehem Foundry & Machine Co.; H. T. Matthew, of the Quigley Furnace Specialty Co.; R. C. Campbell, of the United Filters Co. and C. L. Bryden, of the Vallez Filters Co.

¹See CHEM. & MET., vol. 26, No. 20, May 17, 1922.

Tariff Commission Issues Preliminary Summary of Census of Dyes and Coal-Tar Chemicals

A preliminary summary of Census of Dyes and Coal-Tar Chemicals, 1921, has been issued by the Tariff Commission on the request of Senator McCumber, chairman of the Finance Committee. This summary represents a special investigation made by the Tariff Commission as to the production and sales of dyes and other coal-tar chemicals in the United States. The final report will appear later under the title "Census of Dyes and Organic Chemicals, 1921."

The preliminary survey is based upon the production of 200 firms. It contains a brief summary of important developments in the output of dyes and coal-tar chemicals during 1921. Detailed tables are given showing the production of crudes, dyes and intermediates, and other coal-tar chemicals in 1921. In addition these tables contain, for the first time, the quantity and value of the sales of each product. Figures for each product are given in all cases where publication does not reveal the operations of individual manufacturers. Prices of a selected list of dyes from 1917 to 1921 are tabulated, with the invoice values of the same dyes imported in 1914. Comparison tables showing the quantity of production in 1920 and 1921 are given; also a comparison of the production of dyes classified according to method of application.

A detailed census of dyes imported for consumption in the United States during the calendar year 1921 is contained in the report. This tabulation shows the quantity and value of imports of individual dyes and the percentage of the quantity of each dye by countries or origin. A list of manufacturers whose production during 1921 was reported to the Tariff Commission is also included.

Affiliated Technical Societies of Detroit Hear Tour on Atmospheric Nitrogen

At a meeting of the Affiliated Technical Societies of Detroit, Mich., in that city on May 19, R. S. Tour, professor of chemical engineering at the University of Cincinnati, spoke on the fixation of atmospheric nitrogen.

The importance and necessity of nitrogen production was first mentioned in its relation to nitrogen fixation and the three commercial processes were described in a general way and their relative advantages and disadvantages stated. With the aid of lantern slides, the applications of the cyanamide and Haber processes at the United States nitrate plants were pointed out. The conditions under which these plants were built and their relation to the power project at Muscle Shoals were also considered. Finally, the proposals now before Congress for the private operation of the Muscle Shoals project were mentioned and their important points described. The address was followed by two reels of films showing Nitrate Plant No. 2 in construction and operation.

Badische Reports Increased Earnings

According to the *Boersen Courier* the Badische Anilin- und Soda-Fabrik realized in 1921 gross earnings of 404,733,311 marks, against 194,185,659 for the previous year. The net profit stands at 165,261,933 marks, as compared with 65,184,493 for 1920, and the dividend on the ordinary shares is 30 per cent, against 20 per cent last year, but owing to the increase of capital the amount distributed this year to ordinary shareholders is 120,000,000, compared with 36,000,000 last year. The report states that the Oppau ammonia works resumed operations in December and has been working at full capacity since February.

Charge Illegal Dye Sales Methods

The Federal Trade Commission has issued formal complaint against Dudley G. Gessler, engaged in selling dye and dyestuffs, in Philadelphia, Pa. The respondent has thirty days in which to answer, after which the case will be tried on its merits.

Respondent is charged with giving cash commissions or gratuities in substantial amounts to textile mill operators and supervising officials of customers to secure purchase for respondent's commodities over and to the exclusion of respondent's competitors' commodities.

Synthetic Chemical Industry Championed in House as Giant of Utility

A plea for support instead of criticism of the synthetic chemical industry was made by Representative Layton of Delaware in a speech before the House in which he characterized the synthetic chemical and the electrical industries as twin giants of modern power and usefulness.

Mr. Layton stated that while electricity enjoys the approbation of the public, the synthetic chemical industry is surrounded by ignorant prejudice which retards its progress and may if continued extinguish its development. He charged that the cry against those engaged in the national development of the synthetic chemical industry came from demagogue, German interests and the selfishness of the textile industry. The Congressman recalled the former public aversion to the steel, oil and copper interests, but said they were now looked on with pride as being part of our national strength and greatness.

"But when now the question of dyes comes up, involving the potentiality of our wage," he continued, "a howl of protest is raised against those engaged in manufacturing this and other products of coal tar as if some enormity were being perpetrated or perfected against the welfare of the people, notwithstanding the fact that synthetic chemistry and its results are paramount to any other scientific pursuit with characteristics of a fundamental necessity in peace and war. This is an age of chemistry. The dreams of the ancient alchemists have come true. The chemical laboratory possesses a greater productive power for health, agriculture, national defense, for use in textiles, for bodily ailments and for a multitude of other things than we find in all the electrical, steel or other establishments of the land."

Mr. Layton emphasized the great importance of fostering protection and establishment upon sure and impregnable basis of the industry founded upon science. It would be stupidly criminal for Congress to be influenced by forces that seek to destroy the industry, he asserted. He referred to Senator King of Utah as the chief champion of the interests of the German dye manufacturer in opposing the dye industry, and closed by advocating protection for the American industry.

Sodium Nitrate Awards

Seventy-nine bids were received by the Director of Sales for the 16,450 short tons of sodium nitrate sold on May 17. The average price received was \$38.44. The successful bidders were as follows:

Trojan Powder Co.	Allentown, Pa.	200 tons	\$42.20
Hubbard Fertilizer Works	Baltimore, Md.	100 tons	42.00
Senior Powder Co.	Cincinnati, Ohio	100 tons	41.40
Trojan Powder Co.	Allentown, Pa.	200 tons	41.20
Senior Powder Co.	Cincinnati, Ohio	100 tons	41.20
G. F. Taylor, Inc.	New York City	200 tons	41.00
Senior Powder Co.	Cincinnati, Ohio	100 tons	40.70
King Powder Co.	Cincinnati, Ohio	500 tons	40.50
Senior Powder Co.	Cincinnati, Ohio	100 tons	40.30
E. I. du Pont de Nemours	Wilmington, Del.	2,000 tons	40.30
Trojan Powder Co.	Allentown, Pa.	200 tons	40.20
Graselli Chemical Co.	Cleveland, Ohio	1,000 tons	40.00
International Agricultural Corp.	New York City	165 tons	40.00
Granton Chemical Co.	New York City	375 tons	40.00
G. F. Taylor, Inc.	New York City	200 tons	40.00
Farmers Fertilizer Works	Elizabethtown, Pa.	100 tons	40.00
York Chemical Works	York, Pa.	100 tons	40.00
Trojan Powder Co.	Allentown, Pa.	200 tons	39.20
Union Explosives Co.	Clarkburg, W. Va.	250 tons	39.00
G. F. Taylor, Inc.	New York City	200 tons	39.00
Caleo Chemical Co.	Bound Brook, N. J.	400 tons	38.50
Trojan Powder Co.	Allentown, Pa.	200 tons	38.20
Merrimac Chemical Co.	Boston, Mass.	150 tons	38.20
Wessel-Duval & Co.	New York City	4,000 tons	38.10
G. F. Taylor, Inc.	New York City	200 tons	38.00
Hubbard Fertilizer Works	Baltimore, Md.	100 tons	38.00
York Chemical Works	York, Pa.	100 tons	38.00
Atlas Powder Co.	Wilmington, Del.	5,000 tons	38.00

Power Company Supplements Shoals Offer

An offer to the War Department to purchase the Gorgas power plant and the government's interest in the railroad and transmission line from Gorgas to Muscle Shoals for \$2,500,000 has been made by the Alabama Power Co. The offer has been submitted to the Senate Agriculture Committee by the War Department, this committee having under consideration the various lease offers.

Committee on Agriculture Investigates Charges of Fertilizer Monopoly

Charges which have been made in both houses of Congress of an alleged fertilizer trust are being investigated by the Senate Committee on Agriculture in connection with its consideration of the lease offers for Muscle Shoals. Secretary of Agriculture Wallace will be among those heard by the committee in an effort to get at the truth.

The charges that a "fertilizer trust" controls prices, fixing them so high that the farmers are unable to buy in quantities sufficient to meet their needs, were declared to be largely without substance by Francis L. Hawes, of the Federal Trade Commission.

Mr. Hawes told of the investigation of the fertilizer industry concluded in 1915 by the Federal Trade Commission, and declared that so far as the commission had learned since that time there was "no combination in restraint of trade" in the fertilizer business. Supply and demand, he said, were the factors regulating the industry at the present time. The committee, however, decided to look into the charges further.

Dedication of State Ceramics Building Arranged by Ceramic and Clay Workers' Societies

The New Jersey Clay Workers' Association and Eastern Section of the American Ceramic Society is perfecting arrangements for the dedication of the new state ceramics building at Rutgers College, State University of New Jersey, New Brunswick, on June 13, to be carried out during the regular annual commencement period at the institution. The building is now nearing completion, and represents an aggregate investment of close to \$125,000, including donations made by companies in the industry in the state and vicinity. Brief addresses will be made by a few prominent speakers, including R. H. Minton, president of the Clay Workers' Association.

On the day following, June 14, the association will hold its regular mid-year meeting at the Country Club at Trenton, N. J. The business session will be limited to the afternoon, the morning being given over to sports and sight-seeing, with possible visits to local potteries.

Petroleum Testing Methods Published

The long-promised report on "Methods for Testing Petroleum Products" as adopted by the Government Interdepartmental Petroleum Specifications Committee, is now available as Technical Paper 298 of the Bureau of Mines. These methods are formulated in what is virtually a handbook for inspecting laboratories. The use of the methods is compulsory under government purchases. The specifications required for such government purchases are included in another technical paper of the bureau also issued recently. It is Technical Paper 305 of the Bureau of Mines.

It is being urged that the standard testing procedures and the standard specifications thus recommended by the government be widely adopted in the interest of uniformity of petroleum marketing and tests. Copies of each paper can be obtained on application to the Bureau of Mines.

Chemical and Oil Company Organizations

During the month of April twenty companies were organized with a capital of \$50,000 or larger to manufacture chemicals, chemical byproducts, drugs, etc., with aggregate capitalization of \$20,055,000. This compares with a total of twenty-five such concerns formed in March, with combined indicated capital of \$12,625,000. In the corresponding month of April of a year ago the aggregate capitalization of new companies formed was \$9,390,000.

In this same month, April, 1922, ninety-five oil companies were organized, with an indicated gross capitalization of \$154,590,000, as compared with an aggregate of seventy-nine oil companies, with capital of \$50,000 or larger, formed in the preceding month, with combined capital of \$156,571,000. In the same month of April a year ago 110 such companies were chartered, with a gross indicated capital of \$227,470,000.

Personal

WILLIAM HUTTON BLAUVELT has resigned his position with the Semet-Solvay Co., of Syracuse, N. Y., and has opened an office as consulting engineer in the Equitable Building, 120 Broadway, New York City, where he will give special attention to the carbonization of fuels and allied subjects. Mr. Blauvelt has been connected for many years with the Semet-Solvay and Solvay Process companies, and has taken a prominent part in the development of the byproduct coke industry in America. On account of his broad experience in the carbonization of coal, production of gas for domestic and industrial purposes, the recovery of byproducts and the general utilization of fuels, he is a recognized authority on these subjects. The first important installation of byproduct recovery gas producers, of the Mond type, was brought to this country and put into operation under his direction during the earlier years of his association with the Solvay companies.

F. F. CHAPMAN of E. I. du Pont de Nemours & Co. is on a prolonged tour of the Western acid plants of the company.

BJARNE COLBJORNSEN, chemical engineer of the Stockholm Superphosphate Works, is in this country, making a survey of American fertilizer manufacturing practice.

Prof. A. C. H. FASIG, head of the department of applied sciences of Muhlenberg (Pa.) College, addressed the Kiwanis Club, Allentown, Pa., at its regular weekly dinner meeting at the Hotel Allen, May 18, on the subject "The Growth of Chemistry in the United States."

FRANCIS J. HALL, vice-president of the Central Iron & Steel Co., Harrisburg, Pa., and connected with the company for the past 20 years, has resigned, effective May 31.

JOHN R. JOHNSON, who will receive his doctor's degree in June from the University of Illinois, has been awarded one of the Field scholarships to France. He will continue his research at the Sorbonne.

HUGO C. LARSON, of the University of Illinois, has received a fellowship from the Scandinavian-American Foundation and will sail in June for Stockholm, where he will work in the Royal Technical Institute on the metallurgy of special steels.

F. J. METZGER was elected vice-president of the Air Reduction Co., Inc., in charge of research and development, at a meeting of the board on May 24.

FRANK R. MILLER has left the American Agricultural Chemical Co. after 38 years of service, to open an office as an "advertising engineer" in the Widener Building, Philadelphia, Pa.

H. STIRLING SNELL has just returned from a trip of inspection through some of the principal French chemical manufacturing in the interest of William Heap & Sons, of Grand Haven, Mich., with which concern he is connected.

CHARLES R. SPARE has been elected president of the American Manganese Bronze Co., Philadelphia, Pa., with plant in the Holmesburg Junction section. He organized the company about 15 years ago and is the inventor of the bronze manufactured by the company.

Prof. HAAKON STYRI, director of research, SKF Laboratories, Philadelphia, discussed before the Washington Chapter of the American Society for Steel Treating on May 22 the subject "Preparation and Heat-Treatment of Ball-Bearing Steel."

Obituary

EDWARD G. LOCKE, founder of the Locke Glazed Paper Co., Philadelphia, Pa., died at his home at Camden, N. J., on May 16, from paralysis. He was 65 years of age. Mr. Locke is survived by his wife and a daughter.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Our Service Department

A great many things come to an editor's desk and no small proportion of them are questions. Subscribers, advertisers and casual readers are constantly writing in for information and the editorial department of a technical magazine is looked upon as a depository replete with miscellaneous knowledge of practically every field of human endeavor. To some small extent, perhaps, this is justifiable, for in general the editor's experience is remarkably catholic and a wide range of informational sources is usually available to him.

CHEM. & MET.'s editorial staff is no exception to this rule and certainly if we are to judge from some of the appreciative letters which we have recently received from our readers, the practice has come to be regarded as a valuable part of the magazine's service to industry. CHEM. & MET. has gradually developed within its organization an informational bureau equipped to supply data on practically every phase of the chemical, metallurgical and allied industries. This service is offered to its readers with the single reservation that it is in no sense competitive with the admirable work of the professional consultant. In fact we consider it a part of our service to recommend to our inquirers the consulting chemists and engineers who are best qualified to handle the research problems that lie beyond the natural limitations of a gratuitous informational bureau. Technical problems concerning processes, producing operations and equipment are so closely related to editorial matter that they have always received special attention. Furthermore, our research department stands ready to co-operate in locating new sources and uses for materials and equipment.

Naturally the market editors receive a goodly share of these queries, for their field touches on the products of all our industries. In these letters from our readers it is the commercial and economic information about particular commodities that is most often sought. Latest statistics on production, consumption, imports and exports are in demand and in most instances they can be supplied without delay. Others of our readers are desirous of following the trend of prices over some definite period or in greater detail than is afforded by our weighted index number. And, too, we are often asked to review conditions affecting the market for an individual chemical or metallurgical product. Such factors as tariff changes, embargoes and strikes have a prevailing influence on market conditions, and it is our business to keep in touch with these developments.

Our service department has been designed to serve our readers and all are invited to make use of it. Pertinent inquiries will receive careful, intensive study and every effort will be made to supply reliable information bearing on the problems of the chemical and allied industries.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	157.72
Last week	160.49
May, 1917	222
May, 1920	279
April, 1918 (high)	286
April, 1921 (low)	140

The sudden recession of the index number during the past week has resulted from the lower prices quoted for several of the most important commodities on which the index is based. Thus the decline of ammonium sulphate, caustic soda and cottonseed and linseed oil was sufficient to cause a drop of almost 3 points. The fall in the case of linseed oil amounted to 4 cents on the gallon.

The Ten Per Cent Reduction in Freight Rates

Excessive transportation charges are generally regarded as one of the most important factors affecting costs in the chemical and allied industries. These are the industries that furnish most of the basic materials of commerce, and no small share of the delivered cost of their products is directly attributable to the freight rates. Particularly is this true in the case of the heavy chemicals and other bulky materials of comparatively low unit costs.

The general rate reduction of 10 per cent, announced by the Interstate Commerce Commission on May 24, is of more than usual significance, therefore, to the industries that make materials. This is evidenced by the fact that in extended investigation, which began last December and concluded March 15, the commission paid particular attention to such basic commodities as coal, iron and steel, cement, fertilizers, petroleum, paper and pulp and to miscellaneous chemical products such as the alkalis, creosote oil, explosives, glass, insecticides, naval stores, soda ash, etc.

THE COMMISSION'S FINDINGS

The commission found that on and after July 1, 1922, freight rates would be unreasonable to the extent that they may exceed the rates in effect Aug. 25, 1920, by specified percentages in the various rate groups of the country, so applied to make reductions in each group equivalent to 10 per cent. These percentages are as follows:

In the Eastern group, also between points in Illinois territory and between Illinois territory and the Eastern group, 26 per cent instead of the 40 per cent authorized in the last decisions.

In the Western group, and between the Western group and Illinois territory, 21.5 per cent instead of the 35 per cent previously authorized.

In the Southern and mountain-Pacific groups, 12.5 per cent instead of the 25 per cent previously authorized.

On interterritorial traffic, except as otherwise provided, 20 per cent instead of the 33½ per cent previously authorized.

These rates, in the opinion of the commission, will enable the railroads to earn a net return of 5.75 per cent upon the aggregate value of railway properties. This is a reduction of one-fourth of 1 per cent in the fair return authorized March 1, 1920. It is also pointed out that the 10 per cent reduction does not apply in the case of reductions which have been made since August, 1920, except in cases where reductions have been made for the purpose of equalizing rates and correcting inconsistencies.

FREIGHT PROBLEMS IN THE PROCESS INDUSTRIES

The commission's report, which bears the title "Reduced Rates, 1922," contains a number of interesting references to the freight problems of the chemically controlled industries. Under the heading "Cottonseed Products, Vegetable Oils and Soap," the report makes the following comment:

There are about 750 cottonseed-oil mills in the cotton-growing territory of the South. They represent an investment of about 250 million dollars and crush 85 per cent of the cotton seed produced. The products are cottonseed oil, meal, hulls and linters. In 1921 this industry brought its costs down materially below those of 1920. About 500 of the mills were operated in the season 1921-22, 300 of them continuously. The failure to operate more nearly to capacity is attributed in part to high freight rates.

Soap moves for the most part in carlots from factories to distributing points, but there is also a considerable less-than-carload movement from factories. From dis-

tributing points the movement is in less than carloads. The principal raw materials used are fats, greases and oils. Caustic soda, soda ash, lime and borax are also largely used. The aggregate inbound and outbound tonnage of materials and product was estimated at 3,000,000 tons annually, much of it moving for considerable distances. Delivered prices of soap were said to be about 33½ per cent over those of 1914. The soap manufacturers asked that as soon as a reduction in rates is possible it be made horizontally in all rates.

The paper manufacturers asked for rate reductions not only on their finished product but on their raw materials such as woodpulp, coal, clay, sulphur, resin and tallow. Between 3 and 4 tons of these materials are required to produce 1 ton of newsprint. The principal contention of the papermakers was that the rates on paper from New England were relatively lower than those in effect from Western mills. The New England shippers urged the commission "to prescribe rates on newsprint paper not exceeding 80 per cent of the rates on book, printing and wrapping paper, with sixth-class rates as maxima, and further that reductions should be made from New England to Chicago and Western points, even though reductions were not made from the Western mills. They also contended that, if reductions are to be general, the rates from New England to points in the Eastern group should be lowered to a greater extent than rates from Western mills."

The commission declared, however, that the evidence does not warrant fixation of the proper rate relationship between these competing mills.

The report points out that the fertilizer industry is most seriously concerned with transportation charges for two reasons: (1) The manufacturer pays both the freight on his raw materials and the outbound charges on the finished product. (2) The price of fertilizer is very closely approaching its 1914 price. This is recognized by the commission, which reports on the situation as follows:

The extent to which fertilizer is used is determined to a considerable degree by the farmer's ability to obtain credit. This is confirmed by the carriers. Local dealers or distributors have been accustomed at the beginning of the planting season to extend such credit to mature with the crops, in turn depending upon the fertilizer manufacturers for credit. Some of these manufacturers said that since the price to the farmer is practically upon a pre-war level, rate reductions must be made, and the benefit retained by them in order to enable them to continue the customary extension of credit, thereby indirectly benefiting the farmer. Others said that a reduction will immediately inure to the purchaser.

The fertilizer for use in production of this year's crops has already moved, but the annual movement of raw materials into the fertilizer plants does not begin until May. Fertilizer manufacturers asked that reductions ranging from 20 to 25 per cent be made on fertilizer materials and that on fertilizer we prescribe for the southern group a distance scale of rates suggested by them.

The New York Market

NEW YORK, May 29, 1922.

Activity in the chemical market during the past week was limited to a few special items and a feature among these has been the recent strength of the prussiates. Both the soda and the potash salts have recorded new high levels for the year, with the former showing pronounced advance because of the scarcity of spot material. Caustic soda remained very firm for nearby shipments of standard brands. The export demand continues in good proportions from continental Europe, Italy and the Far East. British and French prices remain considerably above American prices and this condition is causing a demand for American goods. Soda ash continues along its former lines, with demand only moderate for domestic and export consumption. Permanganate of potash was a shade easier due to competition. Arsenic is showing the effect of renewed interest and the market was somewhat firmer. Copper sulphate continues very strong, with a steady demand for domestic consumption. There has been very little business done in the rest of the list and the general buying movement was quite irregular.

GENERAL CHEMICALS

Arsenic—Some improvement is recorded in this item from consuming quarters and sellers are asking 7¼@7½c. per lb. for spot and nearby shipments of the white powdered. Supplies are not very heavy and the market is set for an advance.

Barium Chloride—Dealers of spot material report a pronounced scarcity. Producers, however, are offering material at \$95 per ton f.o.b. works. Quotations among resale dealers range around \$100@\$105 per ton. June delivery from abroad is held at \$95 per ton.

Bleaching Powder—Domestic factors quote large drums at \$1.60 per 100 lb., f.o.b. works. Imported goods remain unchanged at \$1.65 ex-dock. The demand is only moderate.

Caustic Potash—Small-lot sales have been made around 6c. per lb. for the imported 88-92 per cent, but a conspicuous absence of round-lot trading was noted. Any additional inquiries will have a strengthening effect on spot prices.

Caustic Soda—Foreign inquiries covering a wide range continue to reach this market and the undertone is quite firm. Domestic shipments of standard brands are quoted at \$3.85@\$3.90 per 100 lb. f.o.b. New York. Large producers report a steady call for contract shipments.

Chlorate of Potash—Domestic makers quote 8c. per lb. for prompt shipment. Odd lots of imported material are on the market at 6¾@7c. per lb. The inquiry has shown no unusual activity during the past week.

Chlorate of Soda—Sales of spot material are reported by dealers, but only for small quantities at 6¼c. per lb. Large lots can be shaded down to 6¼c. per lb. Leading producers quote the market at 6¼c. f.o.b. works. A moderate consuming inquiry is recorded.

Prussiate of Soda—The consuming industry has become more interested in this item during the past week, through reduced spot offerings and the steadily advancing prices. The tone of the market late in the week became exceptionally buoyant and several advances were recorded. Holders were asking 25c. per lb., with only a few odd tons available.

Sal Ammoniac—A few lots of imported white granular were on the market at 7c. per lb. Domestic goods were quoted at 8c. per lb. Gray offerings were not very liberal and most sellers were holding prices at 8c. per lb.

WAXES

Beeswax—The feature in the market was the strength in African Crude, which sold as high as 19¼c. per lb. Stocks in all grades are rather light.

Carnauba Wax—Demand for this product was not very active, but prices held steady at primary centers. No. 3 North Country was offered at 16c. per lb. No. 2 North Country held around 25c. per lb.

Japan Wax—There were offerings on spot at 16¼c. per lb., with nearby goods quoted at 16c. and futures at 15¼c. per lb. The market was somewhat quiet and the general tone was barely steady.

Montan Wax—Supplies were very plentiful on spot and the market was irregular, ranging from 4c.@4¼c. per lb.

Paraffin Wax—The domestic demand is up to expectations, but the export inquiry is very dormant and trading is rather quiet. Match wax is moving moderately, with leading dealers quoting 4¼@4½c. per lb. Crude scale, 122-124 deg. melting point, was offered at 2¼c. per lb. Fully refined, 123-125 deg. melting point, sold under 3c. per lb. during the week.

NAVAL STORES

Turpentine (Spirits)—While trading in general was rather quiet toward the latter part of the week, the advance in prices was sustained and the market closed at 95c. per gal, ex-yard. Supplies on spot were reported limited.

Rosins—Trading in the different grades was active during the past week and with the Southern market higher, prices in the local market advanced from 10@25c. per barrel. The market during the latter part of the week was quiet, but prices ruled steady.

The St. Louis Market

ST. LOUIS, Mo., May 23, 1922.

There have been no changes of importance in the industrial chemical market in this locality since our last report. Business continues to increase and prices generally are very firm.

ALKALIS

The *caustic soda* market remains firm and fairly active, the demand for small lots being especially good. Prices have not changed any since our last report, but a gentle rise would not be altogether unexpected. *Soda ash* is remaining uniform both in price and quantity, no variations being felt either way in this market. *Sodium bicarbonate* has become somewhat stabilized since our last report, with no decline noted recently. *Sal soda* continues to move in its regular channels and at uniform prices as of our last report.

GENERAL AND SPECIAL CHEMICALS

Heavy mineral acids continue to move in a fair way. However, a much larger volume of business could be transacted if it were not for the fact that the steel mills are being restrained in their operations, due to the coal situation. One manufacturer reports a good demand from the fertilizer trade. *Citric acid* is still in good demand with no change in price. *Acid tartaric* and *cream of tartar* are beginning to show signs of improvement, and orders of larger volume are now passing. The market for *white arsenic powdered* has shown some slight improvement. Prices generally are firm and quoted at 6½@7c. f.o.b. New York. *Carbon bisulphide*, being a seasonable article, is now moving very freely. *Glycerine* continues weak and although the regular market quotation is 15c. in drums, a good-sized substantial contract was recently placed at less than 14½c. *Sodium fluoride* is now in better demand, with prices firm. *Sulphur* continues in stiff demand and prices need not be expected to drop. The present time is proper for placing large orders, since there is no indication of a decline. The prices quoted in our last report for *zinc sulphate* remain unchanged. However, an advance is anticipated owing to the increase in price for *zinc spelter*.

VEGETABLE OILS AND NAVAL STORES

Linseed oil has not changed since our last report and continues firm at \$1.07 basis raw oil. It is rather unusual that the market on linseed oil should not fluctuate in two weeks, but the lack of contract inquiries probably accounts for this. *Turpentine* reached the remarkable height of \$1.04 a few days ago, but is now back to \$1. With the *rosin* market regaining its natural health, turpentine bids fair to hold up. *Castor oil* is unchanged. Prices firm and demand good.

PAINT MATERIALS

The recent sunshine has worked a wonderful improvement both in demand for material and in the attitude of the grinders. No price changes have been noted, but a fair amount of carload business on dry earth colors has been done recently, the purchasers seeking to get covered before the expected import duty goes into effect.

The Iron and Steel Market

PITTSBURGH, May 26, 1922.

Except for decided activity in connection with three important lines of steel consumption, the turnover in steel products is now light, much lighter than in March and April. The mills are well sold up for a couple of months or more, and buyers, with some exceptions, are well covered. The relation is such that the sellers have the advantage.

The three lines of steel consumption in which active buying at the present time is represented are the building of freight cars and motor vehicles and the erection of skeleton steel work. Freight car orders, having averaged, roughly speaking, about 15,000 cars a month since the first of the year, are still in evidence, even more strongly than in the first 2 or 3 months of the year. The buying is at about the average pace that obtained in the 10 years 1904 to 1913. The proportion of steel production passing

to the railroads is, however, greatly reduced, for there is less steel called for by railroads in lines outside of freight cars, and the steel-making capacity is greatly increased.

Production of passenger automobiles this month will probably exceed 200,000 cars, an almost complete report for April having shown 196,412 cars, apart from 21,944 trucks. With steel required for accessories, equipment, etc., the automobile industry at large is probably consuming finished rolled steel at the present time at a rate of nearly if not quite 150,000 gross tons a month. Production of finished rolled steel at a rate of 2,300,000 or 2,400,000 gross tons a month.

In the past 2 months placing of fabricated steel contracts has been approximately equal to the fabricating shop capacity, while contracts in the first quarter of the year represented only a trifle over half the capacity, and the average for the year 1921 was 35 per cent.

STEEL PRICES STRONG

With steel production at only about 70 per cent of the full capacity, a market has been produced as strong as obtained before the war only when the mills were operating at 90 to 100 per cent. The coal strike, apparently, makes the difference.

Bars, shapes and plates are quotable at 1.60c. as the minimum of the regular market, and are by no means easy to buy at that price. Several mills are quoting \$2 to \$3 a ton more, and are probably booking some business, when prompt delivery is requisite. Particularly attractive orders for plates and shapes may possibly go at concessions, especially if, as in the case of the average freight car order, the negotiations were started long ago.

Hoops are being quoted at 2.25c. It is not long since that the market firmed up to 2c. Apparently the mills have larger delivery obligation than they thought they were taking when they were so eager to sell early in the year. Sheets and tin plates are very stiff at regular prices, while in sheets not a few mills are asking \$5@\$7 a ton extra.

The higher prices now ruling for steel do not increase profits. The familiar experience of its requiring several months of activity for the mills to dispose of low priced business is being repeated, hence there is particular interest in the subject of steel demand next Autumn. A continuance of present pressure for steel will result in reasonable profits. There is easily enough momentum to carry the mills through the summer, normally a dull period in the market.

PRODUCTION HEAVY

Steel ingot production is running at somewhat over 37,000,000 gross tons a year. Output last December was at a rate of 20,000,000 tons, the rate rising rapidly in 3 months, to about 35,000,000 tons April 1. Since then there has been a slight increase, despite the coal strike.

LOWER COKE PRICES

Connellsville coke, which advanced sharply about 10 days ago, had an equal drop early this week, and is now quotable at \$3.25@\$3.50 for steam grade. Dealers attribute the drop to Secretary Hoover's interest in coal prices, not that producers voluntarily reduced their asking prices, but that some Eastern buyers, expecting lower prices, withdrew from the market, and the relation between demand and offerings effected the change.

Connellsville coke, on the other hand, has advanced nearly a dollar a ton in the week. Offerings have been very limited and at times there has been practically no inquiry, but a few days ago buying orders began to appear, in connection with the possible resumption of two steel works furnaces. The makers involved appear to be getting such premiums for their steel as to be able to pay rather fancy prices for coke, especially since furnace grade is now \$7@\$7.50.

The pig iron market remains stagnant, inquiry being almost absent. Prices are practically nominal, at \$26 for bessemer, \$25 for basic and \$24 for foundry, f.o.b. valley furnaces.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.		\$0.38 - \$0.40
Acetone.....lb.	\$0.08 - \$0.09	0.09 - 10
Acid, acetic, 28 per cent.....100 lbs.	2.35 - 2.50	2.55 - 3.00
Acetic, 56 per cent.....100 lbs.	5.00 - 5.25	5.30 - 5.50
Acetic, glacial, 99½ per cent, carboys.....100 lbs.	9.25 - 9.50	9.75 - 10.25
Boric, crystals.....lb.	11 - 11½	11½ - 12
Boric, powder.....lb.	11 - 11½	11½ - 12
Citric.....lb.		45 - 46
Hydrochloric.....100 lb.	1.10 - 1.20	1.25 - 1.70
Hydrofluoric, 52 per cent.....lb.	11 - 11½	11½ - 12
Lactic, 44 per cent tech.....lb.	0.09 - 10	10 - 12
Lactic, 22 per cent tech.....lb.	0.04 - 0.04½	0.04 - 0.05
Molybdic, a.p.....lb.	3.00 - 3.25	3.30 - 3.75
Muriatic, 20 deg. (see hydrochloric).....lb.	0.06 - 0.06½	0.06½ - 0.07
Nitric, 40 deg.....lb.	0.06½ - 0.06½	0.07 - 0.07½
Nitric, 42 deg.....lb.	0.06½ - 0.06½	0.07 - 0.07½
Oxalic, crystals.....lb.	13½ - 14	14 - 14½
Phosphoric, 50 per cent solution.....lb.	0.08 - 0.08½	0.08½ - 0.09
Picric.....lb.	22 - 24	24 - 30
Pyrogallol, resublimed.....lb.		1.65 - 1.75
Sulphuric, 60 deg., tank cars.....ton	10.00 - 11.00	
Sulphuric, 60 deg., drums.....ton	12.00 - 14.00	
Sulphuric, 66 deg., tank cars.....ton	15.00 - 16.00	
Sulphuric, 66 deg., drums.....ton	19.00 - 20.00	20.50 - 21.00
Sulphuric, 66 deg., carboys.....ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	19.50 - 20.00	
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	22.00 - 22.50	23.00 - 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.....lb.		40 - 75
Tannic (tech.).....lb.	40 - 45	46 - 50
Tartaric, imported crystals.....lb.		28 - 28½
Tartaric acid, imported, powdered.....lb.		28 - 30
Tartaric acid, domestic.....lb.		1.00 - 1.10
Tungstic, per lb. of WO.....gal.		4.75 - 4.95
Alcohol, ethyl.....gal.		
Alcohol, methyl (see methanol).....gal.		
Alcohol, denatured, 188 proof No. 1.....gal.		32 - 34
Alcohol, denatured, 188 proof No. 5.....gal.		32 - 34
Alum, ammonia, lump.....lb.	0.31 - 0.31½	0.04 - 0.04½
Alum, potash, lump.....lb.	0.31 - 0.31½	0.04 - 0.05
Alum, chrome, lump.....lb.	0.71 - 0.08	0.08 - 0.08½
Aluminium sulphate, commercial.....100 lb.	1.50 - 1.65	1.70 - 2.25
Aluminium sulphate, iron free.....lb.	0.21 - 0.21½	0.03 - 0.03½
Aqua ammonia, 26 deg. drum (750 lb.).....lb.	0.07 - 0.07½	0.08 - 0.08½
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	0.30 - 0.30½	0.31 - 0.33
Ammonium carbonate, powder.....lb.	0.07 - 0.07½	0.07 - 0.08
Ammonium nitrate.....lb.	0.06 - 0.06½	0.06½ - 0.07½
Amylacetate tech.....gal.		2.00 - 2.25
Arsenic, white, powdered.....lb.	0.71 - 0.71½	0.07 - 0.08
Arsenic, red, powdered.....lb.	12 - 12½	12½ - 13
Barium chloride.....ton	105.00 - 106.00	107.00 - 110.00
Barium dioxide (peroxide).....lb.	20 - 21	21 - 22
Barium nitrate.....lb.	0.06 - 0.07	0.07 - 0.08
Barium sulphate (precip.) (blanc fixe).....lb.	0.31 - 0	0.04 - 0.04½
Blanc fixe, dry.....lb.	0.04 - 0.04½	
Blanc fixe, pulp.....ton	45.00 - 55.00	
Bleaching powder.....100 lb.	1.60 - 1.75	1.80 - 2.75
Blue vitriol (see copper sulphate).....lb.	0.51 - 0.51½	0.06 - 0.06½
Borax.....lb.	27 - 28	28½ - 35
Bromine.....lb.	1.75 - 2.00	
Calcium acetate.....100 lbs.	0.41 - 0.41½	0.05 - 0.05½
Calcium carbide.....lb.	24.00 - 24.50	24.75 - 27.00
Calcium chloride, fused, lump.....ton	0.11 - 0.11½	0.02 - 0.02½
Calcium chloride, granulated.....lb.		1.40 - 1.50
Calcium peroxide.....lb.		15 - 16
Calcium phosphate, tribasic.....lb.		79 - 81
Campheor.....lb.	0.06 - 0.06½	0.07 - 0.07½
Carbon bisulphide.....lb.	0.09 - 10	10 - 12
Carbon tetrachloride, drums.....lb.		60 - 75
Carbonyl chloride, (phosgene).....lb.		
Caustic potash (see potassium hydroxide).....lb.		
Caustic soda (see sodium hydroxide).....lb.		
Chalk, precip.-domestic, light.....lb.	0.41 - 0.41½	
Chalk, precip.-domestic, heavy.....lb.	0.41 - 0.41½	
Chalk, precip.-imported, light.....lb.	0.41 - 0.41½	
Chlorine, gas, liq. cyl.-cylinders (100 lb.).....lb.	0.05 - 0.05½	0.05½ - 0.06
Chloroform.....lb.		35 - 37
Cobalt oxide.....lb.		2.00 - 2.10
Copperas.....ton	20.00 - 22.00	23.00 - 30.00
Copper carbonate, green precipitate.....lb.	19 - 20	20½ - 21
Copper cyanide.....lb.		58 - 60
Copper sulphate, crystals.....100 lb.	6.00 - 6.15	6.25 - 6.50
Cream of tartar.....lb.		25 - 26
Epsom salt (see magnesium sulphate).....gal.		60 - 65
Ethyl acetate com. 85%.....gal.		90 - 95
Ethyl acetate, pure (acetic ether, 98% to 100%).....gal.		0.09 - 0.09½
Formaldehyde, 40 per cent.....lb.	16.00 - 17.00	
Fullers earth, f.o.b. mines.....net ton	30.00 - 32.00	
Fullers earth-imported powdered-net ton		2.15 - 2.50
Fusel oil, ref.....gal.		1.30 - 1.50
Fusel oil, crude.....gal.		15 - 15½
Glauber's salt (see sodium sulphate).....lb.		4.20 - 4.25
Glycerine, a. p. drums extra.....lb.		12 - 18
Iodine, resublimed.....lb.		12 - 12½
Iron oxide, red.....lb.	14 - 14½	14½ - 15½
Lead acetate.....lb.		15 - 20
Lead arsenate, powd.....lb.	0.71 - 0.08	0.08 - 0.09
Lead nitrate.....lb.	0.08 - 0.08½	0.09 - 0.09½
Litharge.....lb.	2.50 - 2.60	2.65 - 2.85
Magnesium carbonate, technical.....lb.		1.00 - 1.80
Magnesium sulphate, U. S. P.....100 lb.		57 - 58
Magnesium sulphate, technical.....100 lb.		59 - 60
Methanol, 95%.....gal.		11 - 11½
Methanol, 97%.....gal.		11 - 11½
Nickel salt, double.....lb.		45 - 46
Nickel salt, single.....lb.		47 - 50
Phosgene (see carbonyl chloride).....lb.		30 - 35
Phosphorus, red.....lb.		
Phosphorus, yellow.....lb.		

	Carlots	Less Carlots
Potassium bichromate.....lb.	0.09 - 0.10	0.10 - 0.10½
Potassium bromide, granular.....lb.		17 - 20
Potassium carbonate, U. S. P.....lb.	12 - 12½	13 - 16
Potassium carbonate, 80-85%.....lb.	0.04 - 0.05	0.05 - 0.06
Potassium chlorate, powdered and crystals.....lb.	0.06 - 0.07	0.07 - 0.08
Potassium cyanide.....lb.		42 - 45
Potassium hydroxide (caustic potash).....100 lb.	6.00 - 6.25	6.35 - 7.00
Potassium iodide.....lb.		3.30 - 3.40
Potassium nitrate.....lb.	0.07 - 0.07½	0.08 - 0.09
Potassium permanganate.....lb.	14 - 14½	14½ - 20
Potassium prussiate, red.....lb.	nominal	nominal
Potassium prussiate, yellow.....lb.	32 - 32½	32½ - 33
Rochelle salts (see sodium potas. tartrate).....lb.	0.07 - 0.07½	0.07 - 0.08
Salammoniac, white, granular.....lb.	0.07 - 0.08	0.08 - 0.08½
Salammoniac, gray, granular.....100 lb.	1.20 - 1.40	1.45 - 1.60
Salsoda.....ton	20.00 - 25.00	
Salt cake (bulk).....100 lb.	1.65 - 1.70	2.00 - 2.25
Soda ash, light, 58 per cent flat, bags, contract.....100 lb.	1.90 - 2.00	2.10 - 2.50
Soda ash, light, 58 per cent flat, bags, resale.....100 lb.	1.95 - 2.05	2.10 - 2.60
Soda ash, dense.....100 lb.	0.05 - 0.05½	0.05 - 0.06
Sodium acetate.....100 lb.	1.80 - 1.90	1.95 - 2.40
Sodium bicarbonate.....lb.	0.07 - 0.07½	0.07 - 0.08
Sodium bichromate.....ton	4.50 - 4.60	4.65 - 5.50
Sodium bisulphate (nitre cake).....lb.	0.04 - 0.04½	0.04 - 0.05
Sodium bisulphate powdered, U.S.P.....lb.	0.06 - 0.06½	0.06 - 0.07
Sodium chloride.....long ton	12.00 - 13.00	
Sodium cyanide.....lb.	22 - 23	23½ - 25
Sodium fluoride.....lb.	0.09 - 0.09½	0.09 - 0.10
Sodium hydroxide (caustic soda) solid, 76 per cent flat, drums, contract.....100 lb.	3.35 - 3.50	3.80 - 4.00
Sodium hydroxide (caustic soda) solid, 76% flat, drums, resale.....100 lb.	3.85 - 3.90	3.95 - 4.25
Sodium hydroxide (caustic soda), ground and flake, contracts.....100 lb.	3.85 - 4.00	4.30 - 4.50
Sodium hydroxide (caustic soda) ground and flake, resale.....100 lb.	4.00 - 4.15	4.40 - 4.60
Sodium hypsulphite.....lb.	0.03 - 0.03½	0.03 - 0.03½
Sodium nitrite.....lb.	0.08 - 0.09	0.09 - 0.09½
Sodium peroxide, powdered.....lb.	28 - 30	31 - 35
Sodium phosphate, dibasic.....lb.	0.03 - 0.04	0.04 - 0.04½
Sodium potassium tartrate (Rochelle salts).....lb.	25 - 25½	25½ - 25½
Sodium prussiate, yellow.....lb.	85 - 1.00	1.05 - 1.25
Sodium silicate, solution (40 deg.).....100 lb.	2.35 - 2.50	2.55 - 2.90
Sodium silicate, solution (60 deg.).....100 lb.	0.95 - 1.05	1.15 - 1.50
Sodium sulphate, crystals (Glauber's salt).....100 lbs.	0.04 - 0.04½	0.04 - 0.05
Sodium sulphide, fused, 60-62 per cent (conc.).....lb.	0.03 - 0.03½	0.03 - 0.04
Sodium sulphite, crystals.....lb.	0.09 - 0.10	0.10 - 0.12
Strontium nitrate, powdered.....lb.	0.04 - 0.05	0.05 - 0.06
Sulphur, crude.....ton	18.00 - 20.00	
Sulphur dioxide, liquid, cylinders extra.....lb.	0.08 - 0.08½	0.09 - 0.10
Sulphur (sublimed), flour.....100 lb.		2.25 - 3.10
Sulphur, roll (brimstone).....100 lb.		2.00 - 2.75
Talc-imported.....ton	30.00 - 40.00	
Talc-domestic powdered.....ton	18.00 - 25.00	
Tin bichloride.....lb.	0.09 - 0.09½	0.09 - 0.10
Tin oxide.....lb.	14 - 14½	35 - 37
Zinc carbonate.....lb.	0.06 - 0.06½	0.06 - 0.08
Zinc chloride, gran.....lb.	42 - 44	45 - 47
Zinc cyanide.....lb.	0.07 - 0.08	0.08 - 0.08½
Zinc oxide, XX.....100 lb.	2.75 - 3.00	3.05 - 3.30

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude.....lb.	\$1.00 - \$1.05
Alpha-naphthol, refined.....lb.	1.10 - 1.15
Alpha-naphthylamine.....lb.	30 - 31
Aniline oil, drums extra.....lb.	15 - 16
Aniline salts.....lb.	22 - 24
Anthracene, 80% n drums (100 lb.).....lb.	75 - 1.00
Benzaldehyde U.S.P.....lb.	1.25 - 1.30
Benzidine, base.....lb.	85 - 95
Benzidine sulphate.....lb.	75 - 85
Benzoin acid, U.S.P.....lb.	60 - 65
Benzoate of soda, U.S.P.....lb.	50 - 55
Benzene, pure, water-white, in drums (100 gal.).....gal.	29 - 35
Benzene, 90%, in drums (100 gal.).....gal.	27 - 32
Benzyl chloride, 95-97%, refined.....lb.	25 - 27
Benzyl chloride, tech.....lb.	20 - 23
Beta-naphthol benzoate.....lb.	3.75 - 4.00
Beta-naphthol, sublimed.....lb.	50 - 55
Beta-naphthol, tech.....lb.	25 - 27
Beta-naphthylamine, sublimed.....lb.	1.50 - 1.60
Cresol, U. S. P., in drums (100 lb.).....lb.	12 - 15
Ortho-cresol, in drums (100 lb.).....lb.	16 - 18
Cresylic acid, 97-99%, straw color, in drums.....gal.	53 - 55
Cresylic acid, 25-97%, dark, in drums.....gal.	48 - 50
Dichlorobenzene.....lb.	06 - 09
Diethylaniline.....lb.	65 - 70
Dimethylaniline.....lb.	36 - 38
Dinitrobenzene.....lb.	22 - 25
Dinitrochlorobenzene.....lb.	22 - 24
Dinitronaphthalene.....lb.	30 - 32
Dinitrophenol.....lb.	33 - 35
Dinitrotoluene.....lb.	22 - 24
Dip oil, 25%, ear lots, in drums.....gal.	24 - 26
Diphenylamine.....lb.	59 - 65
H-acid.....lb.	85 - 1.00
Meta-phenylenediamine.....lb.	90 - 1.00
Monochlorobenzene.....lb.	09 - 11
Monochlorobenzene.....lb.	1.05 - 1.25
Naphthalene crushed, in obls.....lb.	06 - 07
Naphthalene, flake.....lb.	08 - 08
Naphthalene, balls.....lb.	08 - 08
Naphthalonic acid, crude.....lb.	65 - 70
Nitrobenzene.....lb.	10 - 12
Nitro-naphthalene.....lb.	30 - 35
Nitro-toluene.....lb.	15 - 17
Ortho-amidophenol.....lb.	2.40 - 2.50
Ortho-dichlorobenzene.....lb.	15 - 20
Ortho-nitro-phenol.....lb.	70 - 75

Ortho-nitro-toluene.....	lb.	\$0.12	—	\$0.15
Ortho-toluidine.....	lb.	.14	—	.18
Para-amidophenol, base.....	lb.	1.25	—	1.30
Para-amidophenol, HCl.....	lb.	1.30	—	1.35
Para-dichlorobenzene.....	lb.	.13	—	.16
Paranitroaniline.....	lb.	.75	—	.77
Para-nitrotoluene.....	lb.	.60	—	.70
Para-phenylenediamine.....	lb.	1.55	—	1.60
Para-toluidine.....	lb.	1.00	—	1.10
Phthalic anhydride.....	lb.	.35	—	.38
Phenol, U. S. P., drums.....	lb.	.14	—	.15
Pyridine.....	gal.	1.75	—	2.75
Resorcinol, technical.....	lb.	1.30	—	1.35
Resorcinol, pure.....	lb.	1.75	—	1.80
Salicylic acid, tech., in bbls.....	lb.	.25	—	.25
Salicylic acid, U. S. P.....	lb.	.26	—	.26
Solvent naphtha, water-white, in drums, 100 gal.....	gal.	.25	—	.28
Solvent naphtha, crude, heavy, in drums, 100 gal.....	gal.	.10	—	.12
Sulphanilic acid, crude.....	lb.	.24	—	.26
Tolidine.....	lb.	1.20	—	1.30
Toluidine, mixed.....	lb.	.30	—	.35
Toluene, in tank cars.....	gal.	.25	—	.28
Toluene, in drums.....	gal.	.30	—	.35
Xylidines, drums, 100 gal.....	lb.	.40	—	.45
Xylene, pure, in drums.....	gal.	.40	—	.45
Xylene, pure, in tank cars.....	gal.	.45	—	....
Xylene, commercial, in drums, 100 gal.....	gal.	.33	—	.35
Xylene, commercial, in tank cars.....	gal.	.30	—	....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax.....	lb.	\$0.20	—	\$0.21
Beeswax, refined, dark.....	lb.	.26	—	.28
Beeswax, refined, light.....	lb.	.30	—	.32
Beeswax, white pure.....	lb.	.35	—	.40
Candelilla, wax.....	lb.	.25	—	.26
Carnauba, No. 1.....	lb.	.45	—	.46
Carnauba, No. 2, North Country.....	lb.	.25	—	.25
Carnauba, No. 3, North Country.....	lb.	.16	—	.16
Japan.....	lb.	.16	—	.17
Montan, crude.....	lb.	.04	—	.04
Paraffine waxes, crude match wax (white) 105-110 m.p.....	lb.	.04	—	....
Paraffine waxes, crude, scale 124-126 m.p.....	lb.	.02	—	....
Paraffine waxes, refined, 118-120 m.p.....	lb.	.02	—	.03
Paraffine waxes, refined, 125 m.p.....	lb.	.03	—	.03
Paraffine waxes, refined, 128-130 m.p.....	lb.	.04	—	.04
Paraffine waxes, refined, 133-135 m.p.....	lb.	.04	—	.04
Paraffine waxes, refined, 135-137 m.p.....	lb.	.05	—	.05
Stearic acid, single pressed.....	lb.	.09	—	.09
Stearic acid, double pressed.....	lb.	.09	—	.09
Stearic acid, triple pressed.....	lb.	.10	—	.10

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50 gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.....	280 lb.	\$5.40	—	\$5.55
Rosin E-I.....	280 lb.	5.70	—	5.90
Rosin K-N.....	280 lb.	6.00	—	6.60
Rosin W, G-W, W.....	280 lb.	7.25	—	7.75
Wood rosin, bbl.....	280 lb.	6.25	—	....
Spirits of turpentine.....	gal.	.96	—	.96
Wood turpentine, steam dist.....	gal.	.85	—	....
Wood turpentine, dest. dist.....	gal.	.70	—	.70
Pine tar pitch, bbl.....	200 lb.	....	—	6.00
Tar, kiln burned, bbl. (500 lb.).....	bbl.	....	—	9.50
Retort tar, bbl.....	500 lb.	....	—	9.00
Rosin oil, first run.....	gal.	.36	—	....
Rosin oil, second run.....	gal.	.38	—	....
Rosin oil, third run.....	gal.	.46	—	....
Pine oil, steam dist., sp.gr. 0.930-0.940.....	gal.	....	—	1.10
Pine oil, pure, dest. dist.....	gal.	....	—	.95
Pine tar oil, ref., sp.gr. 1.025-1.035.....	gal.	....	—	.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.....	gal.	....	—	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990.....	gal.	....	—	.75
Pine tar, ref., thin, sp.gr. 1.080-1.060.....	gal.	....	—	.25
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990.....	gal.	....	—	.25
Pinewood creosote, ref.....	gal.	....	—	.52

Fertilizers

Ammonium sulphate, f.a.s., N.Y.....	100 lb.	3.50	—	3.60
Blood, dried, f.o.b., N. Y.....	unit	3.55	—	3.65
Bone, 3 and 50, ground, raw.....	ton	27.00	—	28.00
Fish scrap, dom., dried, f.o.b. works.....	unit	3.10	—	3.20
Nitrate soda.....	100 lb.	2.70	—	2.80
Tankage, high grade, f.o.b. Chicago.....	unit	3.00	—	3.10
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%.....	ton	3.50	—	3.75
Tennessee, 78-80%.....	ton	7.00	—	7.50
Potassium murate, 80%.....	ton	33.50	—	35.00
Potassium sulphate.....	unit	1.00	—	....

Crude Rubber

Para-Upriver fine.....	lb.	\$0.18	—	.18
Upriver coarse.....	lb.	.12	—	.12
Upriver caucho ball.....	lb.	.13	—	.13
Plantation—First latex crepe.....	lb.	.14	—	.14
Ribbed smoked sheets.....	lb.	.14	—	.14
Brown crepe, thin, clean.....	lb.	.13	—	....
Amber crepe No. 1.....	lb.	.15	—	....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.....	lb.	\$0.11	—	\$0.11
Castor oil, AA, in bbls.....	lb.	.12	—	.12
China wood oil, in bbls.....	lb.	.13	—	.13
Coconut oil, Ceylon grade, in bbls.....	lb.	.08	—	.09
Coconut oil, Cochin grade, in bbls.....	lb.	.09	—	.09
Coru oil, crude, in bbls.....	lb.	.11	—	.11

Cottonseed oil, crude (f. o. b. mill).....	lb.	\$0.10	—	\$0.10
Cottonseed oil, summer yellow.....	lb.	.12	—	.12
Cottonseed oil, winter yellow.....	lb.	.13	—	.13
Linseed oil, raw, car lots (domestic).....	gal.	.86	—	.87
Linseed oil, raw, tank cars (domestic).....	gal.	.82	—	.83
Linseed oil, in 5-bbl lots (domestic).....	gal.	.89	—	.90
Olive oil, denatured.....	gal.	1.15	—	1.17
Palm, Lagos.....	lb.	.07	—	.07
Palm, Niger.....	lb.	.06	—	.06
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.10	—	.10
Peanut oil, refined, in bbls.....	lb.	.12	—	.13
Rapeseed oil, refined in bbls.....	gal.	.83	—	.84
Rapeseed oil, blown, in bbls.....	gal.	.85	—	.86
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.11	—	....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.10	—	....

FISH

Light pressed menhaden.....	gal.	\$0.54	—	....
Yellow bleached menhaden.....	gal.	.57	—	....
White bleached menhaden.....	gal.	.56	—	....
Blown menhaden.....	gal.	.61	—	....

Miscellaneous Materials

Prices remain same as previous report.

Refractories

Quotations remain unchanged.

Ferro-Alloys

Prices same as previous report.

Ores and Semi-finished Products

All quotations remain unchanged.

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	13.875
Aluminum, 98 to 99 per cent.....	19.00
Antimony, wholesale lots, Chinese and Japanese.....	5.40-5.50
Nickel, ordinary (ingot).....	36.00
Nickel, electrolytic.....	39.00
Nickel, electrolytic, resale.....	30.00-33.00
Monel metal, shot and blocks.....	32.00
Monel metal, ingots.....	35.00
Monel metal, sheet bars.....	38.00
Tin, 5-ton lots, Straits.....	31.00
Lead, New York, spot.....	5.50-5.625
Lead, E. St. Louis, spot.....	5.40-5.45
Zinc, spot, New York.....	5.45
Zinc, spot, E. St. Louis.....	5.20

OTHER METALS

Silver (commercial).....	oz.	\$0.72
Cadmium.....	lb.	1.15-1.20
Bismuth (500 lb. lots).....	lb.	2.00@2.10
Cobalt.....	lb.	3.00@3.25
Magnesium.....	lb.	1.05
Platinum.....	oz.	85.000
Iridium.....	oz.	150.00@175.00
Palladium.....	oz.	55.00
Mercury.....	.75 lb.	55.50

FINISHED METAL PRODUCTS

Copper sheets, hot rolled.....	18.75
Copper bottoms.....	27.75
Copper rods.....	19.25
High brass wire.....	16.75
High brass rods.....	14.25
Low brass wire.....	18.25
Low brass rods.....	18.75
Brazed brass tubing.....	23.00
Brazed bronze tubing.....	28.00
Seamless copper tubing.....	20.75
Seamless high brass tubing.....	18.00

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York*	Chicago
Structural shapes.....	\$2.48	\$2.48
Soft steel bars.....	2.38	2.38
Soft steel bar shapes.....	2.38	2.38
Soft steel bands.....	2.98	2.98
Plates, 1/2 to 1 in. thick.....	2.48	2.48

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

BATESVILLE—The American Manganese Co. has preliminary plans under way for the construction of new mills for considerably increased output. The company has an extensive tract of manganese ore in the Batesville-Cushman district and is arranging for extensive development. To provide funds for expansion, a bond issue of \$250,000 is being sold. Norman E. Brokaw is president.

EL DORADO—The El Dorado Oil & Pipe Line Co. has work under way on the rebuilding of its oil refinery, recently destroyed by fire, and will install considerable new machinery. It is expected to have the plant ready for service at an early date.

California

SAN PABLO—The San Pablo Pottery Co. will build two new kilns at its plant and make other extensions.

OAKLAND—The Westgate Metal Products Co., recently organized with a capital of \$2,500,000, to manufacture iron, steel and other metal castings, has tentative plans under consideration for the erection of a new plant. A. T. Burch, 78 El Camino St., heads the company.

Connecticut

HAMDEN—The Kiss Brothers Co., Meriden, manufacturer of pottery products, has acquired the local plant of the Joseph Dixon Crucible Co., and will remodel for a new pottery. Clay properties in this section have also been secured. The company will install necessary equipment and occupy the plant at an early date.

Delaware

WILMINGTON—The Wilmington Sugar Refining Co. has awarded contracts for additional buildings at its new local refining plant, now in course of erection, comprising a 4-story melting and washing building, 60x90 ft., and 1-story power plant, 95x150 ft., to be located at Christiana Ave. and B St. Harding & Craig, Buffalo, N. Y., are contractors. W. J. Wayte, Inc., 125 East 46th St., New York, N. Y., is engineer.

WILMINGTON—James J. O'Neill, manufacturer of leather, has acquired property now occupied under lease on Commerce St., near Dock St., heretofore held by E. Paul du Pont, for a consideration of \$55,000, as a permanent site for his leather tannery. Improvements, it is said, will be made in a number of buildings.

Florida

BRADENTOWN—J. H. Humphries is planning for the establishment of a new plant on local site for the manufacture of commercial fertilizer products.

Georgia

ATLANTA—The Standard Sanitary Mfg. Co., 295 Peachtree St., manufacturer of sanitary earthenware products, has preliminary plans under way for the erection of an addition.

RUTLEDGE—The Rutledge Oil Co. is planning for the rebuilding of the portion of its mill, recently destroyed by fire with loss estimated at close to \$150,000, including equipment. The company is operated by Stanton & Wofford, Social Circle, Ga.

Illinois

CHICAGO—The Chicago Pottery Co., 1924 Clybourn Av., has completed plans for the erection of a 2-story addition, 113x190 ft., and will commence erection at an early date. L. E. Russell, 25 North Dearborn St., is architect.

LEMONT—The Illinois Pure Aluminum Co. has awarded a contract to E. W. Sproul, Pershing Road and Robey St., Chicago, for the erection of a 1-story addition, to cost about \$35,000. Frank D. Chase, Inc., 645 North Michigan Ave., Chicago, is engineer.

CHICAGO, for the erection of a 1-story addition, to cost about \$35,000. Frank D. Chase, Inc., 645 North Michigan Ave., Chicago, is engineer.

Kansas

TOPEKA—The Sunflower Oil & Refining Co. is reported to be planning for the rebuilding of the portion of its plant recently destroyed by fire with loss of about \$40,000.

Louisiana

CEDAR GROVE—The Gulf States Chemical Co., a subsidiary of the National Window Glass Co., is planning for the early operation of its new local plant, now nearing completion, for the manufacture of insect powders and kindred chemical specialties. D. N. Skinner is secretary.

Maryland

BALTIMORE—Ernest E. Stanley, Calvert Bldg., is organizing a new company for the establishment of a plant for the manufacture of chemical products. A building has been leased at Biddle St. and Madison Ave., for the proposed new works.

BALTIMORE—The Argol Sulphite Co., has plans nearing completion for the erection of a new 1-story plant, 40x100 ft., at Curtis Av. and Birch St., and will break ground at an early date.

BALTIMORE—The Edward Richardson Brass Co., 318 North Holliday St., has acquired through its president, Edward Richardson, the former plant of the Zirconium Co. of America, Monument and 11th Sts., recently offered at public auction. The works comprise a group of buildings, with power house, machine shop, etc., and will be used by the new owner. The purchase price is said to be \$38,500.

Massachusetts

DANVERS—The Danvers Welt & Leather Co. is considering tentative plans for the rebuilding of the portion of its plant recently destroyed by fire with loss estimated at about \$40,000, including equipment and stock.

Michigan

SAGINAW—The Aero Cushion Inner Tire & Rubber Co., 907 Ford Bldg., has plans nearing completion for the erection of a new 1-story plant for the manufacture of tires and other rubber products, 80x200 ft., estimated to cost about \$75,000, including equipment. J. J. O'Shaughnessy is general manager.

DETROIT—The Detroit Soda Products Co., 9077 West Jefferson St., has awarded a general contract to the Bennage-McKinstrie Co., 1460 Baldwin Ave., for the erection of a 2-story plant addition, 60x80 ft. L. B. Alger is president.

Montana

COLUMBIA FALLS—The Cyanide Gold Mining Co. has preliminary plans in preparation for the erection of a new mill and cyanide plant, with capacity of about 150 tons a day. It is proposed to commence work at an early date and have the plant ready for service before the close of the year. James La Fountain and T. J. Hollinger head the company.

New Jersey

PERTH AMBOY—The Novo Laboratories, Inc., 651 Catherine St., will commence the immediate erection of a 1-story plant addition for grinding, mixing, etc., to cost about \$25,000. Contract for the building and certain machinery has been awarded. The structure will provide about 2,500 sq. ft. of floor space.

TRENTON—The Clay Products & Mining Corp., recently organized, is arranging to take over the property of the Southern Refractories & Kaolin Co., Fort Payne, Ala. A number of improvements will be made, with extensions for increased production. The company is capitalized at \$1,500,000, and is headed by Richard M. J. Smith and W. P. Cubberly; it is represented by Samuel C. Kulp, 150 East State St., Trenton.

GARWOOD—Three 1-story foundry buildings will be erected by the National Boiler Co., South Ave., estimated to cost in excess of \$30,000. Hooper & Co., 116 Market St., Newark, are architects.

MENDHAM—Leo Robinson, borough clerk, will take bids until 8 p.m., June 12, for the construction of a filter plant and appurtenances at the waterworks.

New York

BUFFALO—The Buffalo Smelting Co. has acquired property, 276x301 ft., on Tonawanda St., as a site for the erection of a new plant for the smelting and refining of copper, brass and other metals. It will consist of a main building, 50x90 ft., and smaller adjoining structures. George Giesen is president.

ALBANY—The Hudson Valley Portland Cement Corp. has work under way on the third unit of its finishing mill, and plans to have the structure equipped and ready for service at an early date. It is proposed to develop an annual output of 1,140,000 bbl. at the plant. To provide for expansion, additional working capital, etc., the company has arranged for a bond issue of \$1,000,000.

PORT JERVIS—Swinton & Co., 47 Main St., will build a new 1-story foundry at their stove works, 72x150 ft., to cost about \$40,000, including equipment. Work will be commenced at once. Robert Livingston, 2 Rector St., New York, is engineer. J. D. Swinton is head.

North Carolina

ASHEVILLE—The Feistone Co., 326 Haywood Bldg., recently organized with a capital of \$100,000, to manufacture concrete and cement products, has plans under way for the erection of a new 1-story plant, 54x100 ft., on site selected near Biltmore, N. C. It will cost close to \$30,000, including equipment. W. L. Gravatt, Jr., is secretary.

OLD FORT—The Old Fort Pottery Works, Inc., recently organized, has preliminary plans in preparation for the erection of a new local plant for the manufacture of earthenware specialties. J. A. Lowery and J. H. Young head the company.

Ohio

CINCINNATI—The Triangle Paper Co., 943 West 6th St., plans for the rebuilding of the portion of its plant destroyed by fire, May 8, with loss estimated at about \$30,000.

Oklahoma

IDAHO—The City Council has plans under way for the construction of a new filtration plant, in connection with a new pumping plant at the waterworks, to cost about \$150,000. The Benham Engineering Co., Gumbel Bldg., Kansas City, Mo., is engineer.

Oregon

SALEM—The Oregon Pulp & Paper Co. is planning for extensions and improvements in its plant to cost about \$55,000. C. F. Beyerl is general manager.

Pennsylvania

PHILADELPHIA—The H. H. Barton & Son Co., 109 South 3rd St., manufacturer of sandpaper and kindred specialties, will soon take bids for the erection of a 2-story plant addition, 40x100 ft. Tilden & Register, 1525 Locust St., are architects. Charles B. Barton is president.

MARCUS HOOK—Fire, May 16, destroyed a portion of the grease-manufacturing plant at the refinery of the Sun Oil Co., Finance Bldg., Philadelphia, with loss estimated at about \$60,000, including equipment and stock.

EAST STROUDSBURG—The Scott-Warman Glass Co., manufacturer of bottles, will commence the immediate rebuilding of its plant, partially destroyed by fire last January, with loss approximating \$150,000. The new structure will cost close to a like amount.

South Carolina

GREENVILLE—The Gray & Son Glass Co., Falls Creek, Pa., manufacturer of rough and ribbed glass, is considering the erection of a new branch plant at Greenville. George R. Gray is president.

Tennessee

NASHVILLE—The Hermitage Portland Cement Co., Chattanooga, has acquired a portion of the Old Hickory plant of the government and is reported to be planning for the construction of a large cement mill on

the site. Present structures will be remodeled and a number of new buildings erected. It is proposed to develop a daily capacity of 2,000 bbl. The new mill will cost in excess of \$1,000,000, with machinery. John C. Vance is president.

Texas

CLARKSVILLE—The Texas Petroleum Co., Fort Worth, W. W. Fisher, president, has plans nearing completion for the construction of a new local refinery of two-unit type, with initial capacity of about 500 bbl. a day.

LARDO—The Texas-Mexican Oil & Refining Co., Milno Bank Bldg., recently organized with a capital of \$150,000, will soon commence the construction of the first unit of its proposed plant on local site, with output of 500 bbl. a day, estimated to cost about \$90,000, including equipment. J. N. Galbraith is president.

Washington

HILLYARD—The Western Materials Co., Valley, Wash., operating local magnesite properties, is planning for the erection of a new plant at Hillyard for the manufacture of magnesite cement, estimated to cost about \$35,000. Negotiations are under way for a site.

New Companies

THE CARRIER CHEMICAL CO., Nitro, W. Va., has been incorporated with a capital of \$150,000, to manufacture chemicals and chemical byproducts. The incorporators are C. F. Carrier, Jr., Archibald Krieg and M. T. Davis, Jr., all of Charleston, W. Va.

THE CROW CHEMICAL CO., Irvington, Newark, N. J., has been incorporated with a capital of \$100,000, to manufacture chemicals and chemical byproducts. The incorporators are Joseph Walsh and Walter Runge, 17 Stengel Ave., Irvington.

THE GRAND RAPIDS BYPRODUCTS CO., Grand Rapids, Mich., has been incorporated with a capital of \$50,000, to manufacture soaps, glue, fertilizer products, etc. The incorporators are William D. Batt, Peter D. Mohrhardt and Victor J. Mollers, all of Grand Rapids.

THE BOSTON PRINTING INK CO., Boston, Mass., has been incorporated with a capital of \$50,000, to manufacture inks and kindred products. Zenas R. Taylor is president; and Daniel S. Schneider, 769 Morton St., Mattapan, Mass., is treasurer.

THE EQUITY PETROLEUM CORP., Wilmington, Del., has been incorporated under state laws, with capital of \$10,000,000, to manufacture petroleum products. The company is represented by the Delaware Charter Co., Ford Bldg., Wilmington.

THE CAPITOL PRODUCTS CORP., Albany, N. Y., has been incorporated with a capital of \$10,000, to manufacture paints, oils, etc. The incorporators are E. H. Brown, P. J. McLure and R. B. Streeter. The company is represented by M. H. Measimer, Albany.

THE STATE PAPER CO., Zanesville, O., has been incorporated with a capital of \$100,000, to manufacture paper products. The incorporators are N. B. and William W. Hanlon, Zanesville.

THE U. S. DRYER & MACHINERY CO., York, Pa., has been incorporated with a capital of \$150,000, to manufacture double shell driers of the rotary type. William J. Kuntz is general manager.

THE GILL CHEMICAL CO., Newark, N. J., has been incorporated with a capital of \$100,000, to manufacture chemicals and chemical byproducts. The incorporators are L. S. Koehler, K. L. and Louis E. Graf, 439 Riverside Ave., Newark.

THE HAYS CORP., Seattle, Wash., has been incorporated with a capital of \$5,000, to manufacture rubber products. The company is headed by Winfield R. Smith, Alaska Bldg., Seattle.

THE STANDARD FOUNDRY & MFG. CO., Kansas City, Mo., has been incorporated with a capital of \$250,000, to manufacture iron and steel and other metal castings. The incorporators are W. H. Simpson, J. B. Harden and H. H. Akers, all of Kansas City.

PULVER & WALDMAN, INC., New York, has been incorporated with a capital of \$5,000, to manufacture chinaware specialties. The incorporators are F. and S. Pulver and L. Waldman. The company is represented by Max Gelles, 1140 Broadway, New York.

THE DECAMP CONSOLIDATED GLASS CASKET CO., Blackwell, Okla., has been incorporated under Delaware laws, with a capital of \$25,000,000, to manufacture glass products. The incorporators are James W. DeCamp, Blackwell; F. H. Butchorn, New

York; and Hilbert B. Mattheson, Orange, N. J. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

THE ROBINHOOD FELDSPAR CO., Robinhood, Me., has been chartered under state laws, to operate a plant for the production of commercial feldspar. Paul Nash is president, and S. M. Neff, treasurer, both of Robinhood.

THE VARCOTE CO., 40 East Kinzie St., Chicago, Ill., has been incorporated with a capital of \$5,000, to manufacture paints, stains, varnishes, etc. The incorporators are W. J. Rankin, B. Z. Hazlett and George H. Johnston.

THE RED CROSS CHEMICAL CO., Fall River, Mass., has filed notice of organization to manufacture chemical products. Martini Barrette, 91 Oak Grove Ave., Fall River, heads the company.

THE FI-BESTOS CO., New York, N. Y., has been incorporated under Delaware laws, with capital of \$100,000, to manufacture asbestos products. The incorporators are Joseph Sandler, David T. Lotwin and Nathan Frankel, New York. The company is represented by Boyce & Magee, Dover, Del.

THE ESSENTIAL OIL CO. OF AMERICA, Tavares, Fla., has been incorporated with a capital of \$25,000, to manufacture essential oils. E. S. Burleigh is president; S. C. Colley, vice-president; and B. W. Hunt, secretary, all of Tavares.

THE AMERICAN RUBBER & BRASS CO., 203 West Lake St., Chicago, Ill., has been incorporated with a capital of \$20,000, to manufacture brass specialties, rubber goods, etc. The incorporators are E. A. and Charles L. Brower, and Arthur J. Cordell.

THE EMLET-WINEBRENNER CO., Hanover, Pa., has been incorporated with a capital of \$30,000, to manufacture chemicals, chemical byproducts, drugs, etc. John M. Emlet, Hanover, is treasurer.

THE NULOID CORP., Wilmington, Del., has been incorporated under state laws, with a capital of \$10,500,000, to manufacture celluloid and other composition products. The company is represented by the Corporation Service Co., Equitable Bldg., Wilmington.

THE H. P. CHANDLEE SONS CO., 112-14 West Lombard St., Baltimore, Md., has been incorporated with a capital of \$200,000, to manufacture chinaware, glass products, etc. The incorporators are George M. and Theodore M. Chandlee, and Jesse Englar.

THE ANACOCO OIL & REFINING CO., Lake Charles, La., has been incorporated with a capital of \$200,000, to manufacture refined petroleum products. The incorporators are B. T. Head, Lake Charles; and T. R. Sutherland, Shreveport, La.

THE ELLA SINGER CO., Atlantic City, N. J., has been incorporated with a capital of \$125,000, to manufacture chemicals and chemical byproducts. The incorporators are A. C. Chism, William J. Riley and Ella Singer, 143 South Virginia Ave., Atlantic City.

THE CHEMICAL PRODUCTS CO., INC., 837 Equitable Bldg., Baltimore, Md., has been incorporated with a capital of \$10,000, to manufacture chemicals and byproducts. The incorporators are Edward C. Hamilton, B. G. Hamilton and Byron R. Webb.

VERNON BROTHERS & CO., Pittsburgh, Pa., are being organized under state laws by Lester B. Vernon and W. R. Cole, to operate a metal smelting and refining plant. Application for a state charter will be made on June 6. The company is represented by George B. Berger, 1737 Oliver Bldg., Pittsburgh.

THE DUNN CONSOLIDATED OIL CORP., Wilmington, Del., has been incorporated under state laws with capital of \$6,000,000, to manufacture refined petroleum products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE DONOVAN PACKING & RUBBER CO., Philadelphia, Pa., has been incorporated with a capital of \$6,000, to manufacture rubber specialties. S. J. Donovan, 211 Bainbridge St., Philadelphia, is treasurer.

THE TWIN FALLS BINDER BOARD MILLS, INC., Scotch Plains, N. J., has been incorporated with a capital of \$10,000, to manufacture paper composition products. The incorporators are David Robinson, Harry S. Sherman and Max Rosenthal, Scotch Plains.

THE OLSTEIN CO., New York, N. Y., has been incorporated with a capital of \$5,000, to manufacture oils, paints, etc. The incorporators are R. and S. Olstein, and M. W. Goodman. The company is represented by Levinson & Feinsod, 277 Broadway, New York.

THE INTERNATIONAL CARBON CORP., Wilmington, Del., has been incorporated under state laws with a capital of \$32,500,000, to

manufacture carbon products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE SMITH ALSOP-BLOOMINGTON PAINT CO., 110 East Front St., Bloomington, Ill., has been incorporated with a capital of \$20,000, to manufacture paints, varnishes, oils, etc. The incorporators are Darrel W. Thompson, Guy W. Frederick and Edward A. White.

THE OWENS PETROLEUM CO., Cameron, Tex., has been incorporated with a capital of \$30,000, to manufacture petroleum products. The incorporators are E. L. and J. R. Mays, and J. S. Owens, all of Cameron.

THE WILCOX-WALTER-FURLONG PAPER CO., Philadelphia, Pa., has been incorporated with a capital of \$75,000, to manufacture paper products. E. T. Walter, Jr., 4701 Wayne Ave., Philadelphia, is treasurer.

THE TUC TOR METAL CORP., New York, N. Y., has been incorporated with a capital of \$200,000, to manufacture metals and metal alloys. The incorporators are E. H. Foster, H. E. Brown and W. M. Smith. The company is represented by Van Vorst, Marshall & Smith, 25 Broad St., New York.

THE NATIONAL FLOOR TILE CO., Mobile, Ala., has been chartered with a capital of \$144,000, to manufacture ceramic floor and wall tile. The company is headed by W. D. Dellingerath, Mobile.

THE EXCELSIOR PAPER CO., Room #11, 11 South LaSalle St., Chicago, Ill., has been incorporated with a capital of \$150,000, to manufacture paper products. The incorporators are L. D. Green, David Alexander and S. Rubin.

THE PENNSYLVANIA OIL CORP., Pittsburgh, Pa., has been incorporated under Delaware laws, with a capital of \$100,000, to manufacture petroleum products. The incorporators are George J. Young, C. E. Arnold and William Devlin. The company is represented by the Capital Trust Co. of Delaware, Dover, Del.

THE TIDEWATER FOUNDRIES CORP., Jersey City, N. J., has been incorporated with a capital of \$10,000, to manufacture iron, steel and other metal castings. The incorporators are E. Mead Whipple, Franklin L. Whitney and Purley C. Butterfield, 170 1st St., Jersey City.

THE PITTSBURGH ABRASIVE CORP., Pittsburgh, Pa., has been incorporated under Delaware laws with capital of \$600,000, to manufacture abrasive products. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington, Del.

THE HARBOR OIL CORP., Eldorado, Ark., has been incorporated under Delaware laws with capital of \$1,000,000, to manufacture petroleum products. The incorporators are S. Williams, L. T. Langston and O. J. Lockhart. The company is represented by the Delaware Registration Trust Co., 900 Market St., Wilmington, Del.

THE TRINITY PRODUCTS CORP., New York, N. Y., has been incorporated with a capital of \$10,000, to manufacture stainless steel. The incorporators are R. F. Helles, J. Pfaff and M. T. Quinn. The company is represented by C. M. Davis, 2 Rector St.

Capital Increases, etc.

THE NATIONAL ROSIN, OIL & SIZE CO., 155 North Clark St., Chicago, Ill., has filed notice of increase in capital from \$50,000 to \$100,000.

JOHN W. MASURY & SON, 50 Jay St., Brooklyn, N. Y., manufacturers of paint, etc., have filed notice of increase in capital from \$150,000 to \$250,000.

THE VIRGINIA-CAROLINA CHEMICAL CO., Richmond, Va., has disposed of a bond issue of \$22,500,000, a portion of the proceeds to be used for expansion, additions to working capital, etc. C. G. Wilson is president.

THE CLAY BRICK CO., Grand Rapids, Mich., has filed notice of dissolution under state laws.

THE GORDON PETROLEUM CO., Eastland, Tex., has filed notice of increase in capital from \$75,000 to \$120,000.

THE SHOPE CONCRETE BRICK CO., Las Cruces, N. M., has filed notice of organization to operate in Texas, with capital of \$30,000, and headquarters at El Paso. The company is represented by J. M. Ireland, El Paso.

THE AETNA POWDER CO., Gary, Ind., has filed notice of dissolution under state laws.

THE COLUMBIA SUGAR CO., Bay City, Mich., operating branch refineries at Mount Pleasant, Mich., and Paulding, O., is disposing of a bond issue of \$1,750,000, the proceeds to be used for expansion, general operations, etc. John C. Ross is president.

THE GIBSON OIL CO., Vincennes, Ind., has

filed notice of increase in capital from \$250,000 to \$500,000.

THE JACK DALTON OIL CO., Mineral Wells, Tex., has filed notice of increase in capital to \$1,000,000 for expansion.

THE CLARK PAPER CO., 541 Ridge St., Newark, N. J., has filed notice of dissolution under state laws.

THE COPLAY CEMENT MFG. CO., Coplay, Pa., has called a special meeting of stockholders on June 15, to vote on an increase in capital from \$500,000 to \$1,250,000.

THE W. R. HOLLINGSHEAD CHEMICAL CO., Utica, N. Y., has filed an involuntary petition in bankruptcy, with liabilities stated at \$80,000.

THE MATHIESON ALKALI WORKS, 25 West 43rd St., New York, N. Y., with plant at Providence, R. I., has acquired the plant and business of the Commonwealth Chemical Corp., Newark, N. Y., and will merge the property with its organization.

The plant and property of the **STRONG-CORD TIRE & RUBBER CO.**, Oak Hill Road, Evansville, Ind., will be sold by Henry B. Walker, receiver.

THE JOHN B. LOVE CHEMICAL CO., Wilmington, Del., has been incorporated under state laws with a capital of \$250,000, to manufacture chemicals and chemical by-products. The company is represented by the Delaware Charter Co., 904 Market St., Wilmington.

Industrial Developments

GLASS—The Graham Glass Co., manufacturer of bottles and hollowware, is arranging for the immediate resumption of production at its plant at Loogootee, Ind., following a shutdown for more than a year past. Employment will be given to more than 150 operatives.

The Potomac Glass Co., Cumberland, Md., started operations, May 22, in the new addition to its local blown-glass works, giving employment to about 200 workers as well as a number of apprentices, making a total of over 450 operatives at the entire plant. The addition represents an investment of \$125,000. A new etching plant is being completed and will be placed in service at an early date. The plant is now running full.

Blown-glass plants at Millville, N. J., and vicinity are contemplating an increase in working hours from 8 to 9 hours a day.

LEATHER—The American Hide & Leather Co. has adopted full-time operations at its Sheboygan, Wis., tanning plant, working on heavy upper leather. The Ballston Spa, N. Y., tannery of the company is running at 100 per cent on patent leather and colored side leathers. At Chicago, Ill., operations have been increased at the local tannery to about 80 per cent of capacity for side and calf leathers. The Lowell, Mass., works are now operating at about 50 per cent of normal, recently resuming operations after a shut down.

The Central Leather Co., New York, N. Y., is increasing operations at its plants. The Foucar Leather Co., Woburn, Mass., is advancing production from 1,000 to 1,400 sides of patent leather daily.

RUBBER—The B. F. Goodrich Co., Akron, O., has advanced production about 25 per cent since the first of May, increasing the operating schedule to a full 5-day week. Additional men will be employed.

The Selberling Tire & Rubber Co. is increasing operations at its plants at New Castle, Pa., and Barborton, Ohio.

PAPER—The Rloridan Co. is increasing operations at its pulp mill at Ticonderoga, N. Y., while the lumber mill of the company at Calumet, Mich., is running full under day and night shifts. The Kipawa paper mill of the company has increased production and is now operating on a basis of 150 tons a day, or close to capacity. The Hawkesbury mill is running on a basis of 100 tons a day, against a full capacity rating of 125 tons.

The Tonawanda Board & Paper Co., North Tonawanda, N. Y., is planning for the early resumption of operations, following a shut down for about a year past.

IRON AND STEEL—The Carnegie Steel Co. has resumed operations at its Farrell Works, Sharon, Pa., with blast furnace and thirteen open-hearth mills, following a shutdown from March, 1921. The last units of the plant at Mingo, O., have been placed in operation, making all mills of the company on the producing list with the exception of those at Columbus and Bellaire, O. The plants are developing 80 per cent of the productive capacity of the company for the first time in more than a year.

The Woodstock Operating Corp., Anniston, Ala., has blown in its blast furnace at La Follette, Tenn., following a shutdown

for nearly two years. The company is reported to be arranging for the early resumption of production at its furnace at Anniston.

The American Rolling Mill Co., Middletown, O., is arranging for the early operation of two additional sheet mills at its plant, making twenty-nine such mills on the producing list, as compared with seventeen mills just before the depression in 1921. About 300 men have been added to the working force during the past three weeks.

The Struthers Furnace Co., Youngstown, O., will blow in its 500-ton blast furnace about the middle of June, following a suspension for 18 months past. The unit is being prepared for lighting.

The Eastern Steel Co. has resumed operations at its open-hearth plant at Pottsville, Pa., after a shutdown for 18 months. It is expected to be running full, giving employment to a normal working force at an early date.

The Shenango Furnace Co., Sharpsville, Pa., has blown in another blast furnace at its local plant.

The United States Steel Corp. has blown in another blast furnace at its Gary, Ind., plant, making eighteen out of twenty-seven furnaces now on the producing list. It is expected to place additional units in service at an early date.

The Midvale Steel & Ordnance Co. is arranging to blow in a second stack at its Coatesville, Pa., works early in June.

The Sloss-Sheffield Steel & Iron Co. has blown in its second blast furnace at North Birmingham, Ala., following a suspension for a number of months. The company plans to blow in its Birmingham city furnace early in June.

The Sharon Steel Hoop Co., Sharon, Pa., has resumed operations at all finishing mills at the local plant.

MISCELLANEOUS—The Davison Chemical Co., Baltimore, Md., is increasing production at its local plant in the sulphuric acid and other departments.

With practically all cement mills in the Lehigh Valley district of Pennsylvania running at capacity, the highest shipment for the year of 50,000 bbl. in one day was recorded on May 19. A large part of the distribution came from the plant of the Lehigh Portland Cement Co., Allentown.

Manufacturers' Catalogs

ADAM HILGER, LTD., 75A Camden Road, London, N. W. 1, England, calls attention to a bulletin illustrating and describing the Hilger chemical spectrometer designed for chemical analysis.

THE SUPERHEATER CO., New York, has just received from the press Bulletin T1, on superheaters for stationary power plants. This bulletin explains in detail the latest features of the Elesco superheater.

THE PACIFIC FOUNDRY CO., San Francisco, Cal., has published a bulletin on Corrosion which covers the use of this acid-resisting metal for drain pipe and fittings.

THE TABER PUMP CO., Buffalo, N. Y., in Bull. 131 gives some helpful hints on the application of rotary pumps, also a friction table and conversion scale. This bulletin should be an aid to industrial plants interested in rotary pumps.

THE GRIEBEL INSTRUMENT CO., Carbon-dale, Pa., has issued an attractive catalog, No. 21, listing glassware for laboratory and scientific purposes.

W. S. ROCKWELL CO., New York, calls attention to Bull. 242, on the influence of method of heating and handling on quality and cost of heat-treated products. This bulletin is a supplement to the series of educational papers previously issued and is intended to illustrate the variety of methods of applying the principles of proper heating and handling to different manufacturing requirements and shop conditions. Another bulletin recently issued is No. 243, on stationary and tilting crucible melting furnaces.

THE SANDVIK STEEL, INC., New York City, has issued a 26-page booklet on steel belting. It contains information as to how the steel belt is applied to solving conveying problems, its efficiency, economy, etc. Anyone interested can obtain a copy of this booklet, No. 18-T, by writing to Sandvik Steel, Inc., 233 Broadway, New York City.

THE HARRISON-WALKER REFRACTORIES CO., Pittsburgh, Pa., has issued a leaflet on Thermolith, the all-temperature fire cement.

THE REPEL-ARC FURNACE CO., Indianapolis, Ind., in Bull. 301 gives facts about the Repel-arc furnace.

THE GRISCOM-RUSSELL CO., New York, has published Bull. 904, on the multiwhirl cooler.

THE SPENCER LENS CO., Buffalo, N. Y., has issued a bulletin on a selection of Spencer products for commercial and industrial laboratories. This list has been selected from the company's larger catalog and with special consideration of workers in industrial and chemical laboratories.

THE CUTTER CO., Philadelphia, Pa., has issued a booklet illustrating and describing I-T-E circuit breakers as applied to the protection of electrical and associated machinery in central stations.

THE ESTERLINE-ANGUS CO., Indianapolis, Ind., in Bull. 422, on "Getting Business With Graphics," discusses the possibilities of the use of graphic records in the sale of technical products.

HERMAN A. HOLZ of New York has issued a four-page folder on "Important Progress in the Calorimetry of Gases."

THE INDUSTRIAL AIR ENGINEERING CO., Elyria, O., in an 8-page booklet illustrates and describes the Industrial Air Purifier and Dust Collector.

THE ROLLER-SMITH CO., New York, has issued two new bulletins. No. 820 illustrates and describes PV ammeters and voltmeters and COD indicators and Bull. 560 illustrates and describes inclosed circuit breakers.

CENTURY WOOD PRESERVING CO., Pittsburgh, Pa., has issued a new bulletin on "Adzing and Boring Cross-Ties."

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold a joint meeting with the Pacific Division of the Association, on the occasion of the annual meeting of the latter, in Salt Lake City, June 22 to 24.

AMERICAN ASSOCIATION OF ENGINEERS will hold its eighth annual convention at Salt Lake City, Utah, June 4-6.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Pittsburgh, Pa., Sept. 5 to 9.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Montreal, Sept. 21, 22 and 23. Headquarters will be at the Windsor Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, Canada, June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meeting at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN OIL CHEMISTS' SOCIETY will hold its annual meeting at the Grunewald Hotel, New Orleans, La., June 5 and 6.

AMERICAN PULP AND PAPER MILL SUPERINTENDENTS ASSOCIATION will meet in Kalamazoo, Mich., June 1, 2 and 3.

AMERICAN SOCIETY FOR STEEL TREATING will hold its International Steel Exposition and Convention in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

ANNUAL SAFETY CONGRESS OF THE NATIONAL SAFETY COUNCIL will be held in Detroit, Mich., Aug. 28-Sept. 2.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (EIGHTH) will be held in New York Sept. 11-16.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-ninth annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 12.

NATIONAL LIME ASSOCIATION will hold its annual convention June 14-16 at the Hotel Statler, Cleveland, O.

NEW JERSEY CHEMICAL SOCIETY will meet at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

The following meeting is scheduled to be held in Rumford Hall, the Chemists' Club, New York: June 9—American Chemical Society, regular meeting.